The Effect of 20 mph zones on Inequalities in Road Casualties in London

A report to the London Road Safety Unit

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Contents

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Summary

Aims

This is a companion to the report, *20 mph Zones and Road Safety in London*, which reported that 20 mph zones reduced road traffic casualties by 42%, above background declines within 20 mph zones. This study evaluates the effect of 20 mph zones on inequalities in road traffic casualties in London. Specifically, it:

- Describes the location of 20 mph zones with regard to area deprivation and ethnic minority populations;
- Assesses whether 20 mph zones have differential effects in areas by level of deprivation;
- Assesses whether 20 mph zones have a differential effect on 'White', 'Black', and 'Asian' casualties;
- Assess whether 20 mph zones have historically reduced area level inequalities in casualties;
- Assesses the potential reductions in casualty inequalities in London from future expansion in the number of 20 mph zones.

Background

Previous research for the LRSU identified persisting socio-economic inequalities in road casualties in London at the area level, and suggested that Londoners in 'Black' minority ethnic groups were at relatively higher risk of road casualties than other ethnic groups. Reports from these studies suggested that traffic calming might have a role in reducing inequalities. Many London boroughs target road engineering at high collision (and therefore often at high deprivation) areas with the aim of addressing inequalities. However, to date there has been little empirical evidence on whether traffic calming in general, or 20 mph zones in particular, can reduce inequalities as well as overall numbers of casualties. This study was therefore commissioned to quantify the extent to which 20 mph zones have historically reduced area level socio-economic inequalities in road traffic casualties, to assess whether 20 mph zones have addressed the observed inequalities between ethnic groups in London, and to assess the future potential for 20 mph zones to contribute to reductions in inequalities.

Methods

Analysis was based on STATS19 data, 1987-2006, which record the date, location, user type and ethnicity (since 1995) of every casualty involved in a road traffic collision in London. Using geographical information systems (GIS) these data were linked to a detailed road segment database which included the characteristics of all classified and unclassified roads in London.

We used time series regression to estimate the general trend in casualties on all roads in London and the effects of 20 mph zones on casualties on roads inside and adjacent to 20 mph zones during 1987–2006 across five levels of area deprivation. Using similar methods we estimated the effects of 20 mph zones on reducing 'White', 'Black' and 'Asian' casualties in the period 1996–2006.

Using results from the time series regression we predicted the number of casualties that would have occurred in 2006 across 5 levels of deprivation in the absence of 20 mph zones. These predictions were used to calculate casualties saved due to 20 mph zones.

Finally, we predicted the potential casualty reductions across 5 levels of deprivation if 20 mph zones were to be extended to appropriate residential areas.

Findings

By 2008, there were 399 20 mph zones in London. Since 1991, these have been increasingly situated in more deprived areas, and therefore in areas with an increasing percentage of ethnic minority populations. Between 1987 and 2006, after adjusting for background changes in casualties in each deprivation quintile, we found no evidence that 20 mph zones had had a differential effect by area deprivation for all casualties, child casualties, pedestrian casualties, or car occupant casualties within 20 mph zones. There was weak evidence that 20 mph zones had had a greater effect on numbers killed and seriously injured (KSI) in the least deprived areas within 20 mph zones. Restricting our analysis to 2000–2006 when there was a greater density of 20 mph zones in deprived areas also suggested no differential effects across deprivation quintiles.

Over time, there was strong evidence that the average annual declines in casualties have been greater in the least deprived areas for all casualties, child casualties, pedestrians, cyclists, powered 2-wheelers and car occupants, although no evidence of differential declines in KSI or for child pedestrians. This suggests that overall socio-economic inequalities have been increasing across London over the period 1987–2006.

For all casualties, child casualties, cyclists and car occupants, there was no evidence that the effect of 20 mph zones had been different for the three broad ethnic groups we compared. However, for KSI casualties there was good evidence, and for all pedestrians and child pedestrians there was some evidence, that 20 mph zones have been less effective in reducing casualties in the 'Black' compared with 'White' and 'Asian' groups.

Modelling the number of casualties that would have occurred had 20 mph zones not been implemented suggested that around half of the 1,193 casualties saved in one year (2006) were in the most deprived quintiles. This suggests that the pattern of 20 mph zone distribution has mitigated widening casualty inequalities. More than half of these 'savings' were from reductions in casualties in roads adjacent to 20 mph zones. Modelling the potential impact of implementing future 20 mph zones in areas eligible but not currently covered, suggests that around 700 casualties would be saved in the following year. As eligible areas (with high casualty histories) are now disproportionately in areas with lower deprivation, implementing 20 mph zones in these areas is not likely to decrease area socio-economic inequalities in casualties.

What are the implications for policy and practice?

20 mph zones are an effective measure for reducing road traffic casualties. Results from this study also suggest that historically 20 mph zones have had a role in mitigating what has been a differential background decline favouring least deprived areas by around 15%. However, given that boroughs have targeted 20 mph zones at high collision areas, only a minority of areas eligible for new 20 mph zone implementation are in deprived areas. For future 20 mph zones to contribute to narrowing socio-economic inequalities, these would need to be targeted at those high collision zones that are in deprived areas, although this policy would be less efficient in terms of reducing overall numbers of casualties.

To continue to reduce road traffic casualties, it is still worthwhile implementing 20 mph zones in eligible areas. However, to successfully reduce inequalities in casualties, particularly to address the apparent high rates in 'Black' minority ethnic groups, other strategies will also be needed. Although 20 mph zones have contributed to casualty reduction in all ethnic groups, they appear to have contributed less to reductions in pedestrian casualties, child pedestrians and those KSI in 'Black' ethnic groups, compared with 'Asian' and 'White' groups. Reducing traffic speed and volume is, then, an important strategy for reducing casualties in London's population; however other strategies will also be needed to reduce the higher observed rates in 'Black' ethnic groups. Further research

is required to identify why 20 mph zones appear to be less effective in reducing pedestrian and KSI casualties for some groups, in order to identify potentially modifiable factors amenable to intervention. Further research is also needed to explore the impact of other methods for reducing traffic speed and volume, particularly in those areas unsuitable for 20 mph zones.

1. Introduction

Background

There is a growing body of evidence documenting inequalities in road casualties by socio-economic status, and suggesting inequalities by ethnicity in the UK (Edwards et al 2006, Edwards et al 2007, Graham et al 2002, Lawson and Edwards 1991, Christie 1995). The London School of Hygiene and Tropical Medicine (LSHTM) recently completed two reports for the London Road Safety Unit (LRSU) investigating the relationship between road traffic casualties, deprivation, and ethnicity in London entitled *Deprivation and Road Safety in London* (Edwards et al 2007) and *Road Safety of London's Black and Asian Minority Ethnic Groups* (Steinbach et al 2007). The results of these reports suggest that there are persisting inequalities in casualty rates for different population groups in London. Those in the most deprived areas remain at higher risk, especially as pedestrians, for whom the risk of injury was over twice as high in the most deprived compared with least deprived areas (Edwards et al 2007). Londoners in 'Black' ethnic minority groups were 1.3 times more likely to be injured as pedestrians and car occupants on London's roads than those in 'White' ethnic groups. Further, the relationship between deprivation and injury risk differed across ethnic groups, with those in 'White' and 'Asian' groups at higher risk if they lived in more deprived areas, but no apparent relationship between area deprivation and risk for those in 'Black' groups (Steinbach et al 2007).

While inequalities in road casualty risk are well documented, there is little evidence available on what works to reduce them (Towner et al 2005). In general, current policy approaches aim to reduce inequalities through targeting interventions that are known to be effective at those areas or populations known to be at highest risk (Green and Edwards 2008). As there is good evidence that reducing the speed and volume of traffic reduce casualty rates (see Edwards et al 2007, Part B), it is a reasonable inference that implementing traffic calming, and doing so particularly in areas where there are high rates of deprivation, might reduce not only overall casualty rates, but also area level inequalities in casualties. The LSHTM reports therefore recommend that resources be focused on interventions which reduce traffic speed and volume, hypothesising that these would potentially reduce inequalities if targeted in deprived areas, as well as contributing to casualty reduction targets. Others have suggested the same strategy (Liabo et al 2003). However, it was also noted that the equity gains may be difficult to measure in the short term (Edwards et al 2007: 121). Although reducing the speed and volume of traffic reduces the risk of serious casualties resulting from collisions, it might also

increase the number of collisions if, for instance, the amount of exposure goes up as there is more pedestrian activity in traffic-calmed areas. In the longer term, as more people walk and cycle, the risk differential between walking or cycling and travelling as a car occupant will reduce. In the shorter term, however, continuing differences in exposure between different social groups may offset any reductions in the risk of exposure from traffic-calmed residential streets.

Reducing traffic speed and volume to reduce inequalities

Traffic calming is a key intervention to reduce traffic speed and volume in London and research to date suggests that traffic calming is effective in reducing casualties (Bunn et al 2003; Elvik 2001). However, although it may be reasonable to predict that traffic calming could reduce road casualty inequalities, there have been few studies which have tested this empirically. One small ecological study found a narrowing of the inequalities gap in one UK city that had traffic calming concentrated in the more deprived areas, compared with another city, although the authors note the limitations of such 'natural experiments', which cannot control for all potential confounding factors, and the need for further research to replicate these findings (Jones et al 2005).

A widely used method for traffic calming in urban areas is 20 mph zones, which use road engineering measures such as road humps, speed cushions, raised junctions, chicanes, traffic islands, and road narrowing to physically slow traffic. First introduced in 1991, the number of 20 mph zones in London has grown in recent years, reaching a total of 399 zones by 2008. Local authorities are responsible for designing and selecting sites for 20 mph zones on their roads. A review of recent London borough road safety plans, together with a survey of road safety professionals conducted for our previous research on deprivation and road safety in London, suggested that many local authorities consider deprivation when selecting sites of 20 mph zones (Edwards et al 2007). Road engineers reported that, in general, traffic calming interventions were situated in areas with high levels of collisions. Given the association between deprivation and higher risk of casualties, they believed this would in itself address injury inequality. However, in terms of addressing the differences in casualty risk across London's different ethnic groups, there were considered to be far more challenges; measures such as traffic calming (on which there is the best evidence for effectiveness in reducing casualty rates) are locality based, and therefore more difficult to 'target' at higher risk groups (Green and Edwards 2008, Steinbach et al 2007). Discussions with traffic engineers across different boroughs for this study emphasised the need for any engineering interventions to meet what were often complex policy needs. In addition to reducing overall casualty numbers, road engineering also had to contribute (variously) to other goals, such as improving overall

community 'liveability', promoting walking and cycling, maintaining heritage streetscapes and scenes, and reducing road danger. Using road engineering to reduce inequalities in road traffic casualties is clearly only one goal, and the prioritisation of this compared with other goals is a matter of competing values as well as evidence on effectiveness. However, given the various imperatives to address inequalities in casualties, evaluating the potential impact of 20 mph zones on this outcome is essential.

The LSRU recently commissioned LSHTM to investigate the effects of 20 mph zones on road casualties in a study entitled *20 mph Zones and Road Safety in London*. This study found that historically 20 mph zones have reduced overall casualties within 20 mph zones by 42% above background declines in casualties. The LRSU commissioned this companion report to investigate whether 20 mph zones are effective in reducing inequalities in road traffic casualties in London.

Methodological issues

This study draws on methods developed in our previous research studies on deprivation, ethnicity and road safety in London. To investigate inequalities in road casualties in London, our previous research used casualty groups from STATS19 data categorised by age and road user group (pedestrian, cyclist, powered two-wheeler and car occupant). A comparison of STATS19 data with hospital admission data suggested that, despite known problems with under-reporting, STATS19 data are sufficiently reliable for analysing the links between deprivation and casualties (Edwards et al 2007, Part A6). Casualties were linked to census super output areas (SOAs) through the grid reference of where the collision occurred. To analyse socio-economic differences, all SOAs were then ranked on their Index of Multiple Deprivation (IMD) score and grouped into quintiles. To analyse the relationships between ethnicity and casualty risk, we grouped the police-assigned 'ethnicity' code from the STATS19 data to broad ethnic groups: 'Black', 'Asian', 'White' or 'Other' (Steinbach et al 2007). In our previous research on ethnicity and road safety, we calculated casualty rates for each ethnic group by mapping STATS19 codes to census codes, for which we had population denominators from the Greater London Authority. In the current research, as it is not possible to calculate changes in ethnic populations at the level of SOA, the analysis of differential effects across ethnic groupings is conducted by comparing the numbers of casualties in each ethnic grouping.

The evaluation of effectiveness of 20 mph zones in reducing inequalities in road traffic casualties is a challenge. In terms of evaluating the overall effectiveness of 20 mph zones, we were able to estimate the background changes in road casualties, and to then calculate the effect that implementing a 20 mph zone had on changes in casualties, over

and above that background change. To estimate accurately how effective 20 mph zones have been in changing the *relative risks* across levels of deprivation, we would need information on the populations in each deprivation quintile, in order to calculate relative risks over time, and the effect of the implementation of zones on that relative risk. This is because socio-economic inequalities (here, the relative risk of being injured in the most deprived areas compared to the least deprived areas) may have been narrowing, widening, or staying the same. We would need to know about these trends to know how far 20 mph zones had impacted on existing trends in inequalities. However, population data over time by level of deprivation are not available, thus hindering comparisons of casualty rates over time and across deprivation levels. Therefore conclusions in this report are based on trends in casualty counts and should be interpreted with care.

There are also additional questions about potential differential effects of 20 mph zones on individuals that an ecological study cannot answer. For example, it is possible that the general effect of 20 mph zones on residents of that area might differ by individual socio-economic status if, for example, behaviours or exposure differ by socio-economic status. The reduction of traffic speed within a 20 mph zone might, for instance, encourage more people to walk or cycle in their neighbourhood. It is possible, though, that this 'exposure' might be increased more for some population groups than others. Thus, even if the risk of being injured in a collision has reduced by the same amount in two 20 mph zones in different deprivation quintiles, the number of casualties might be different if there are more people exposed in one than the other after the implementation of the zone.

For identifying the effect on ethnic differences, it is possible to look at individuals, as STATS19 data has information on ethnicity (although see Steinbach et al 2007 for limitations of these data for analysing differences by ethnicity). However, we do not have accurate measures of population size in areas by ethnicity over time, so it is difficult to estimate how 20 mph zones have affected the rates of casualties across ethnic groups over time. Previous research (Malhotra et al 2008) has suggested that in general between 2001 and 2006 there were few differences in the rates of decline across ethnic groupings for children, although there was some evidence that declines for adults had been slower for 'Asian' and 'Black' groups, particularly for 'Asian' car occupants. It is not known whether there were ethnic differences in changes in casualty rates over time in the period before 2000, when casualty rates were in general higher.

Aims

This project aims to evaluate the effectiveness of London's 20 mph zones in reducing road casualty inequalities. Specifically, the research will:

- Describe the location of 20 mph zones with regard to area deprivation and ethnic minority population;
- Assess whether 20 mph zones have differential effects in areas by level of deprivation;
- Assess whether 20 mph zones have a differential effect on 'White', 'Black', and 'Asian' casualties;
- Assess whether 20 mph zones have historically reduced area level inequalities in casualties;
- Assess potential reductions in casualty inequalities from future expansion to the number of 20 mph zones in London.

2. Methods

Three types of analysis were carried out to assess the impact of 20 mph zones on inequalities:

- descriptive analysis – describes the location of 20 mph zones in terms of deprivation and ethnic minority populations;
- multivariable analysis – assesses whether 20 mph zones had differential effects in areas according to deprivation, or differential effects on 'White', 'Black', and 'Asian' casualties.
- predictive analysis – uses results from the multivariable analysis to assess whether 20 mph zones have historically reduced area level inequalities in casualties, and explores whether future expansion of 20 mph zones has the potential to reduce casualty inequalities in London.

A brief summary of the data used in this report follows below (full details on data cleaning and analysis methods are available in *20 mph zones and Road Safety in London, section 2*).

20 mph zones

A data file provided by the LSRU of every 20 mph zone in London was cleaned and checked. The resulting file contained the boundary, start date of engineering works and date that the 20 mph zone came into effect. Using ArcGIS, we overlaid road segments from the Ordnance Surveys Integrated Transport Network (ITN) onto the cleaned 20 mph zones and census lower super output areas (SOAs). Any road segments that crossed either 20 mph zone or SOA boundaries were split at those boundaries to form separate road segments. Every road segment was then assigned to an SOA and a 20 mph zone status ('inside' a completed 20 mph zone, 'adjacent' to a 20 mph zone, or 'outside' 20 mph zones). Road segments were assigned as 'adjacent' to a 20 mph zone if they connected to road junctions within 150 metres of a 20 mph zone. Within each SOA we calculated the length of roads in kilometres and the proportion of roads that were within 20 mph zones in each year.

Measures of casualties

Road traffic collisions and casualty data were taken from the STATS19 data. Using the x and y coordinate and information on the type of road on which collisions occurred, each

collision was assigned to the nearest road segment of the appropriate type. We investigated collisions in which the x and y coordinate was greater than 50 metres from a road of the appropriate type. Collisions which were over 100 metres away from a road segment (e.g. collisions in parks) were excluded from analysis, and all other collisions were assigned to their nearest road segment, regardless of type.

For collisions which occurred on road segments that were either inside, or adjacent, to 20 mph zones, we compared the financial year (i.e. April to March) of the collision to the engineering works and completion dates to assign a 20 mph zone and adjacency status.

Measures of ethnicity

In London, police officers assign an ethnicity category to each casualty and to vehicle drivers or riders. London police have been providing this information since 1995 as an addition to core STATS19 data. Ethnicity is assigned to one of seven categories: 'White-skinned European', 'Dark-skinned European', 'Afro-Caribbean', 'Asian', 'Oriental', 'Arab', and 'Unknown'. This study grouped casualties into four broad ethnic categories (see table 1) and we focus on the first three: 'White', 'Black' and 'Asian'. For further information on the derivation of these groupings and limitations of STATS19 data on ethnicity, see Steinbach et al (2007).

Table 1: Ethnicity groupings

TfL study	STATS19
White	White-skinned European Dark-skinned European
Black	Afro-Caribbean
Asian	Asian
Other	Oriental Arab

Measures of deprivation

Measures of deprivation were taken from the Index of Multiple deprivation 2004 (IMD) which brings together 36 indicators across seven domains of deprivation into an overall score and rank for a geographical area. The index was designed to provide a robust small-area measure of deprivation which encompasses the many different dimensions on which deprivation can be defined and measured. The IMD score is an ordered scale where higher IMD scores indicate relatively more deprived areas (for a full description of the IMD domains, see Noble et al, 2004).

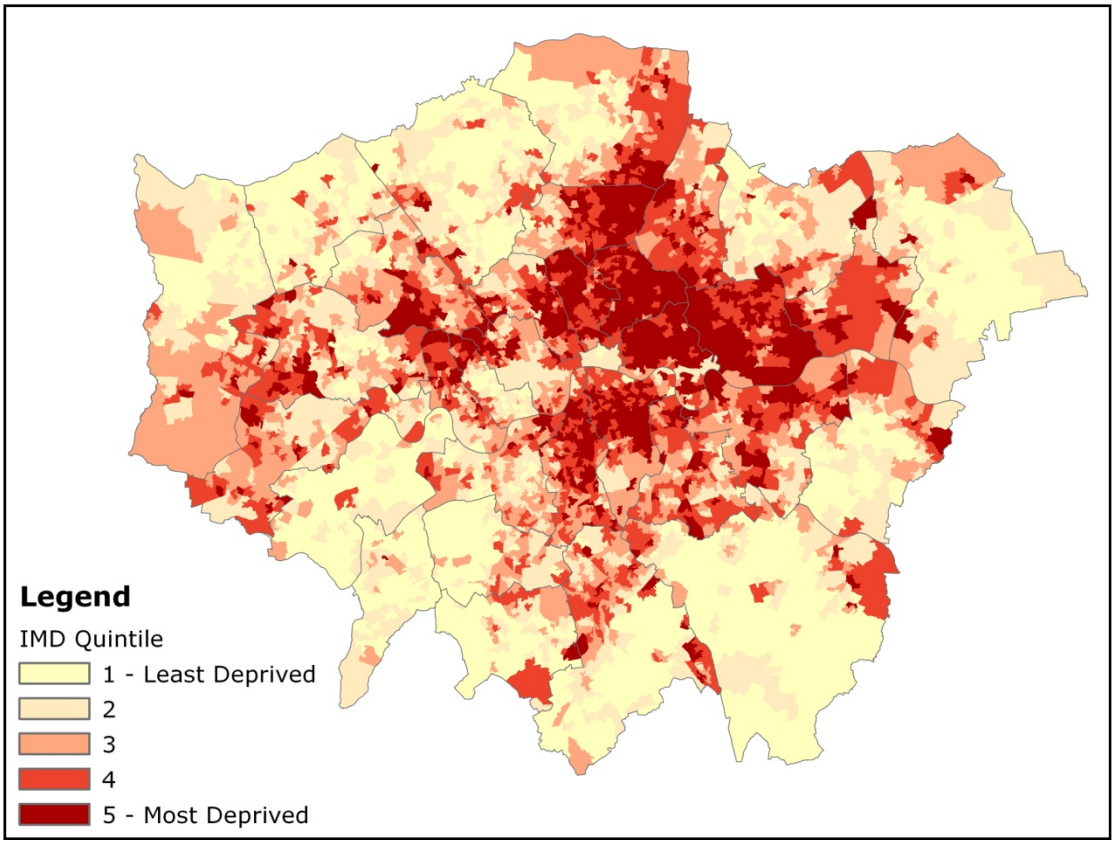
IMD is available at SOA level. SOAs include an average of 1,500 people and were created by the Office for National Statistics (ONS) using measures of population size, mutual proximity and social homogeneity (similarity), to provide robust small-area statistics for use in analyses that seek to compare areas. London has 4,765 SOAs contained within 33 boroughs.

We assigned each road segment an IMD score based on the SOA in which the road segment was located. We assigned each 20 mph zone an IMD score based on the average IMD score of all road segments within the zone, weighted by road length. Much of the analysis in this report uses quintiles of IMD in London. Table 2 shows the range of IMD scores in each quintile.

Table 2: Deprivation quintiles

Deprivation quintile	Range of IMD scores
Least Deprived Q1	2.69 – 11.86
Q2	11.89 – 19.24
Q3	19.25 – 27.64
Q4	27.65 – 37.92
Most Deprived Q5	37.93 – 76.77

Map 1: Relative deprivation in London: 4,765 census super output areas ranked by quintile using the Index of Multiple Deprivation, 2004.



Statistical analysis

Multivariable analysis

To investigate whether 20 mph zones have had any effect on casualty inequalities, we need to establish whether 20 mph zones are equally effective in reducing casualties across all levels deprivation, and equally effective in reducing casualties to 'White', 'Black' and 'Asian' road user groups.

Multivariable methods were based on analysis of change in annual *counts* of casualties within each road segment, using conditional fixed effects Poisson models (implemented in the Stata software package using 'xtpoisson' commands). Each road segment was treated as its own unit of analysis, and the underlying trend over time in number of casualties was modelled as a log-linear function of year (i.e. assuming a constant percentage decline per year across all road segments). The effect of 20 mph zones on casualties in the 20 mph zones themselves, and in adjacent roads, was modelled as a step change (i.e. percentage reduction) occurring from the first year of operation of each 20 mph zone. Results are presented as percentage reductions in casualties with 95% confidence intervals. Standard errors were obtained using a 'jackknife' procedure, clustering on borough to allow for the similarity of outcomes within borough. Socio-economic and ethnic group differentials were examined in relation to: (i) the underlying trend in casualties over time, and (ii) the effect of 20 mph zones. Point estimates are presented by quintile of IMD and for 'White', 'Black', and 'Asian' casualties. Tests of statistical interaction were used to test for heterogeneity between the effect estimates in each quintile, to test for a linear trend across quintiles, and to test for differences between ethnic groups.

These analyses provide evidence about the *relative* change over time in casualties by deprivation group (i.e. whether the percentage decline in casualties is greater or less in deprived areas compared with less deprived areas), and about the *relative* effect of 20 mph zones (percentage reduction) with respect to socio-economic/ethnic group.

Because the analyses use data from 20 years, the results provide reasonably robust estimates of effects. To allow for potential bias due to 'regression to the mean', key analyses were repeated dropping data for three, four or five years prior to the implementation of the 20 mph zones. This examines whether high casualty numbers over these periods with a subsequent decision to implement some 20 mph zones, may have influenced the estimates of casualty reduction attributable to them.

Predictive analysis -- Socio-economic patterns of avoided casualties

To quantify the effect of 20 mph zones on any differentials in *avoided* casualties by deprivation, we used the results of the multivariable analysis to estimate the numbers of casualties expected in 2006, assuming that no 20 mph zones had been implemented. We present numbers of casualties avoided, stratified by deprivation group, by calculating the difference between these estimates of expected casualties and the numbers of casualties observed in 2006. Similar estimates were made for casualties in 2006, assuming that 20 mph zones were extended to all other SOAs not currently covered by a 20 mph zone, where the frequency of casualties per kilometre of road was above the threshold for cost-effectiveness.

3. Results

3.1 Are 20 mph zones located in more deprived areas?

Table 3 shows the length of all roads in kilometres and minor/local roads in 20 mph zones by deprivation quintile. Three hundred and ninety-nine 20 mph zones were implemented in London from 1991–2008 and these cover 2,006 kilometres (11%) of London's roads. A larger percentage of 20 mph zones were in the most deprived areas (31%), and a larger percentage of road kilometres in more deprived areas are now covered by 20 mph zones (27.5%).

Table 3: Kilometres of road in 20 mph zones (% of total road length in deprivation quintile), 2008

	(least deprived) Q1	Q2	Q3	Q4	(most deprived) Q5	Total
all roads	115 (2.5%)	238 (5.9%)	362 (9.7%)	561 (17.7%)	731 (27.5%)	2006 (11.1%)
minor/local roads	98 (3.0%)	207 (7.5%)	310 (12.3%)	495 (22.1%)	629 (34.5%)	1739 (13.8%)
Number of zones*	43 (11%)	54 (14%)	84 (21%)	94 (23%)	124 (31%)	399

*Based on the average deprivation score of roads in 20 mph zones

In *20 mph Zones and Road Safety in London* we reported that the location of 20 mph zones by deprivation quintile has changed over time.

Figure 1 shows the cumulative percentage of road kilometres covered by 20 mph zones by deprivation quintile over time. In 2000, 20 mph zones were spread relatively equally across deprivation quintiles, with less than 2% of roads in all deprivation quintiles covered by 20 mph zones. By 2008, 20 mph zones were disproportionately located in more deprived areas, with 27.5% of roads in most deprived areas of London covered by 20 mph zones compared with 3% of roads in least deprived areas.

Figure 2 shows the location of 20 mph zones by deprivation quintile over time. In 1995 more than 40% of 20 mph zone roads were located in least deprived areas of London, while less than 10% of 20 mph zone roads were located in most deprived areas. By 2008 only 6% of 20 mph zone roads were located in least deprived areas, while 35% of 20 mph zone roads were located in most deprived areas.

Figure 1: Cumulative percentage of road kilometres covered by 20 mph zones

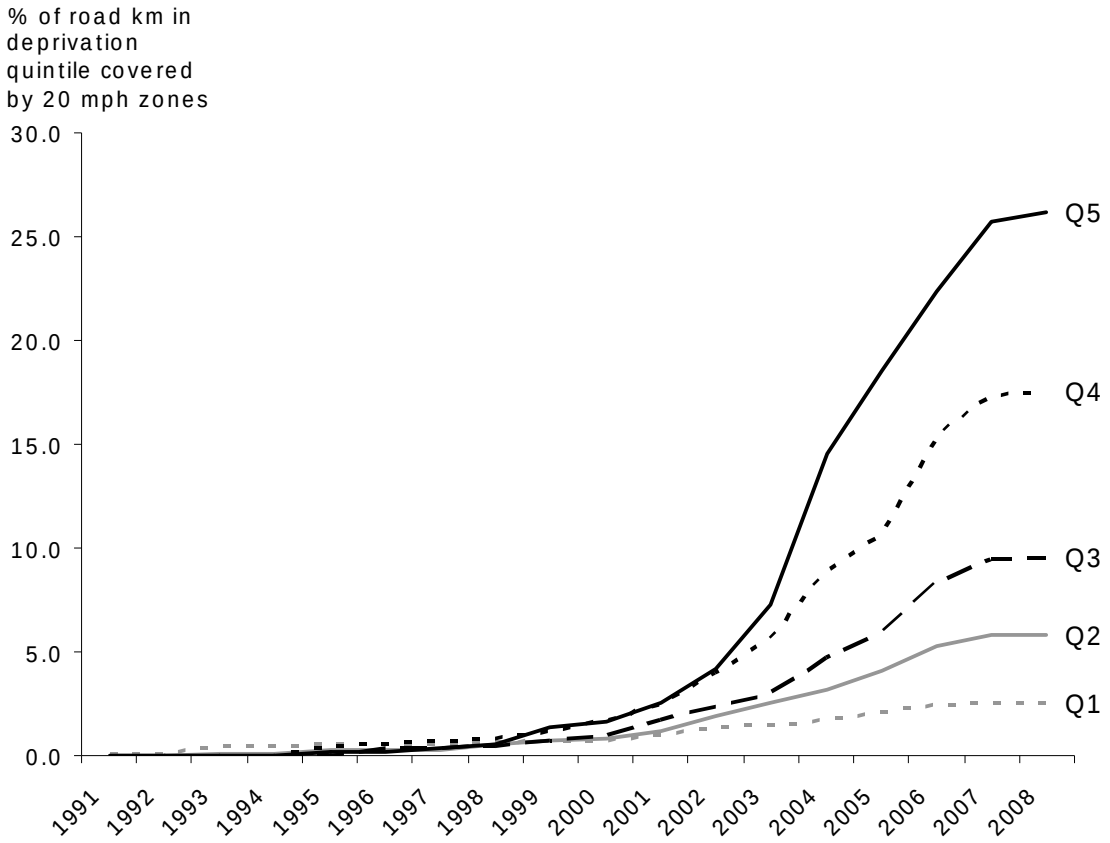
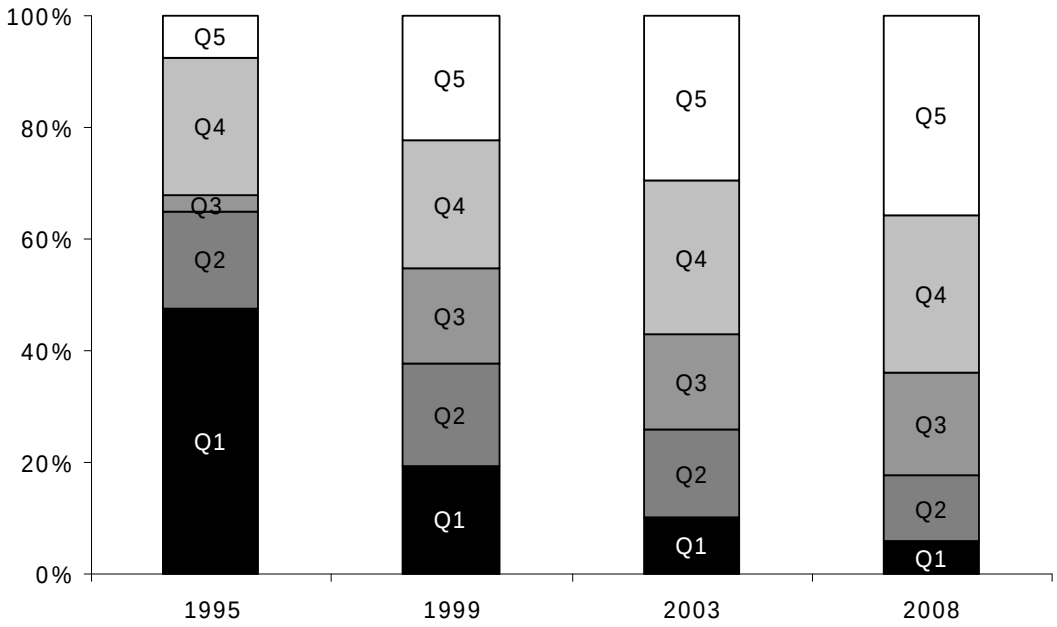


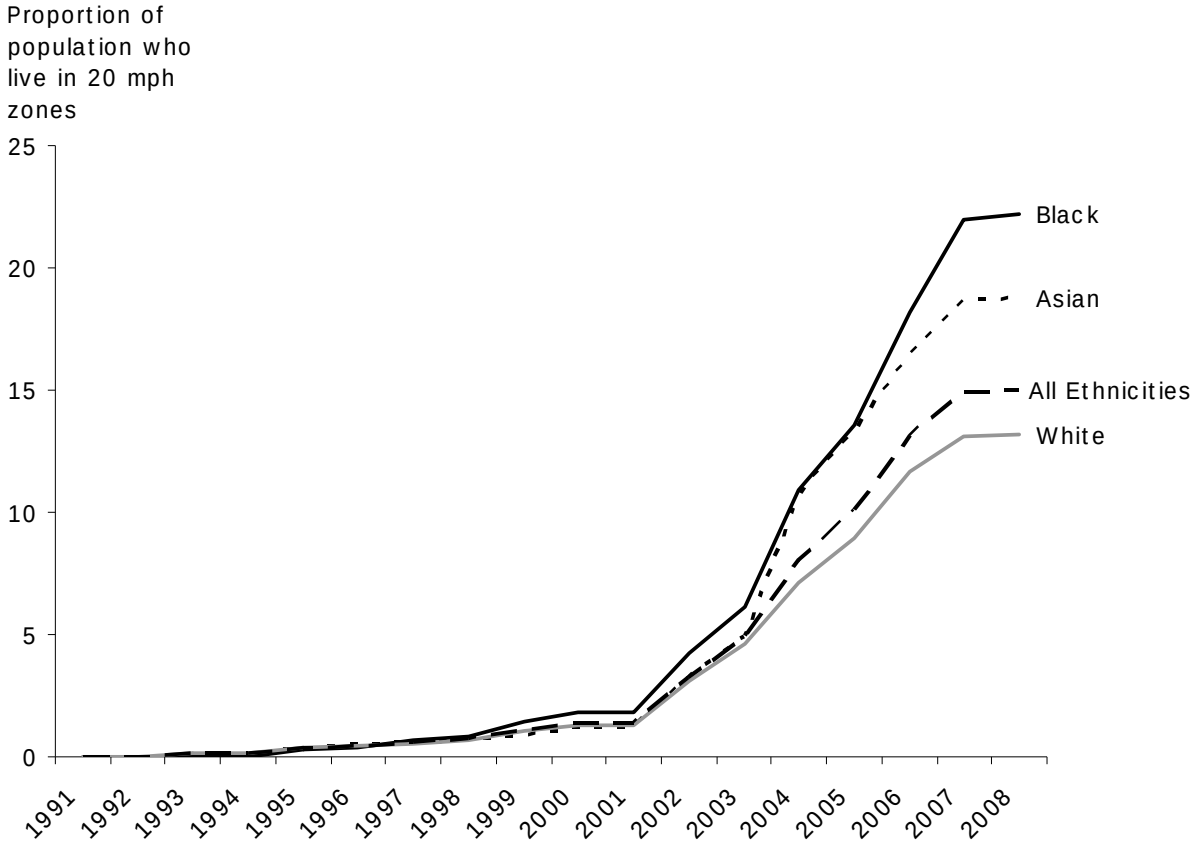
Figure 2: Location of 20 mph zones by deprivation quintile over time



3.2 Are 20 mph zones located in areas with a relatively large ethnic minority population?

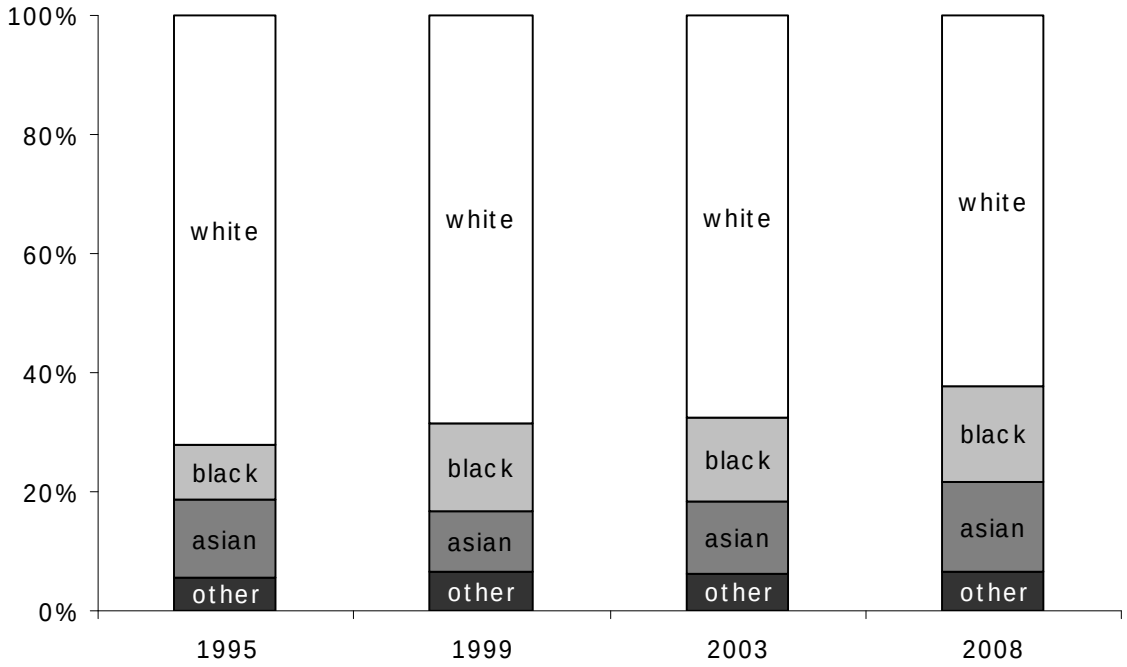
Figure 3 shows the proportion of the 'White', 'Black', and 'Asian' populations living in 20 mph zones over time. The proportion of minority ethnic populations who live in areas covered by 20 mph zones has been increasing over time. Until 1999, a similar percentage of the 'White', 'Black', and 'Asian' populations lived in 20 mph zones. Since 1999 the proportion of 'Black' and 'Asian' populations who live in 20 mph zones has grown more rapidly than the proportion of the 'White' population in 20 mph zones.

Figure 3: Proportion of population living in 20 mph zones by ethnicity



The proportion of the total 'Black' and 'Asian' population living in 20 mph zones is larger than the proportion of the total 'White' population living in 20 mph zones. However, as shown in figure 4, the majority of people living within 20 mph zones are in 'White' ethnic groups.

Figure 4: Percentages of populations living in 20 mph zones by ethnicity



3.3 Are 20 mph zones equally effective in deprived areas?

In the figures shown below, each black diamond shows the point estimate of the percentage *reduction* in casualties following 20 mph zone implementation. The vertical lines through each diamond show the 95% confidence interval for the percentage reduction (based on statistical 'jackknife' procedures that allow for clustering of effects by borough).

For example, figure 5a below shows that in the least deprived fifth of London's areas there was a 42% reduction in all casualties following implementation of 20 mph zones. The vertical line indicates that we can be 95% confident that the true reduction in the least deprived fifth of London's areas was somewhere between 21% and 63%.

Negative values represent a relative increase in casualties. For example, there was an estimated -1% reduction (i.e. a 1% increase) in child casualties on adjacent roads (figure 5d) following implementation of 20 mph zones in the 2nd least deprived quintile.

The models used to derive these estimates allow for the (generally) downward trend over time in the annual number of casualties in London. The models assume that the background trend in casualties declines at a different but constant rate in each deprivation quintile. Full results of the models and the numbers of casualties occurring on

20 mph zone roads, adjacent roads and outside roads by level of deprivation of SOA can be found in Appendix A.

Figure 5: Percentage reduction in casualties in 20 mph zones and adjacent areas, by deprivation of SOA (1987–2006)

Figure 5a: All casualties in 20 mph zones

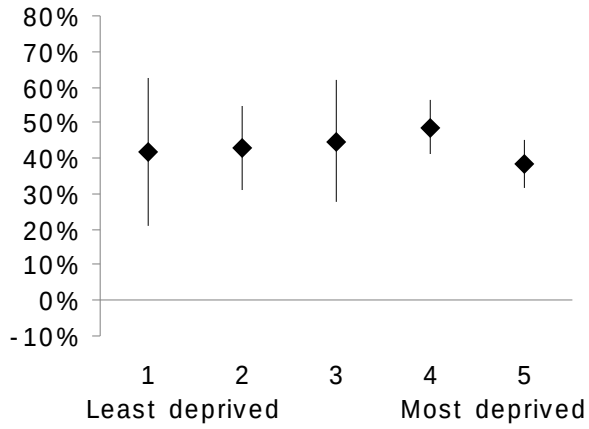
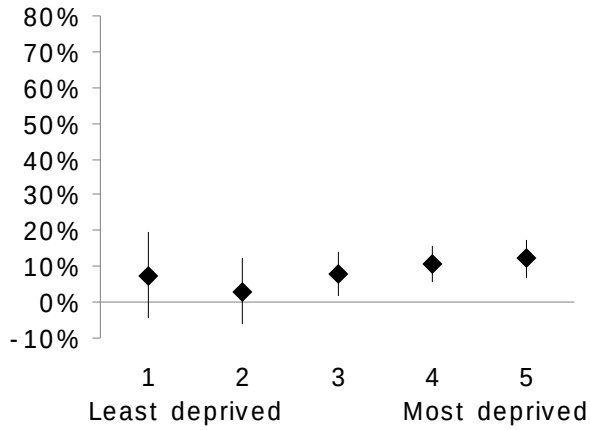


Figure 5b: All casualties in adjacent areas



The reduction in all casualties after implementation of 20 mph zones (figure 5a) was broadly similar across deprivation quintiles (confidence intervals on all estimates overlap), as were the reductions in all casualties seen in adjacent areas (figure 5b).

Similar results across deprivation quintiles were found for child casualties (figures 5c and 5d).

Figure 5c: Child casualties in 20 mph zones

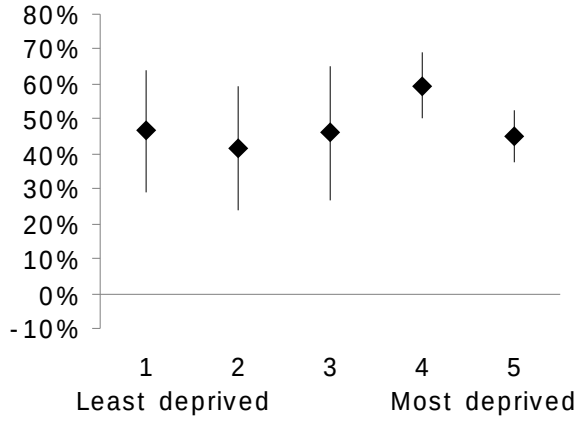


Figure 5d: Child casualties in adjacent areas

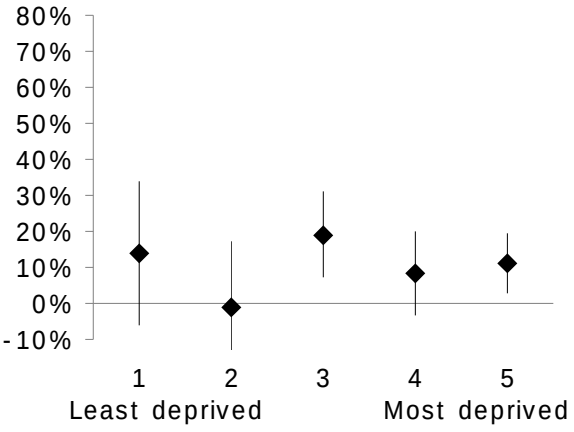


Figure 5e: KSI casualties in 20 mph zones

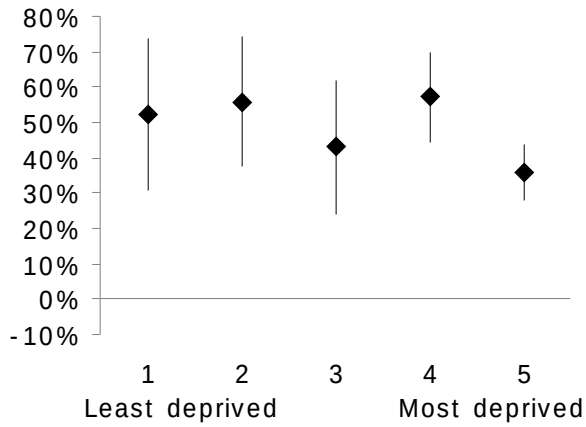
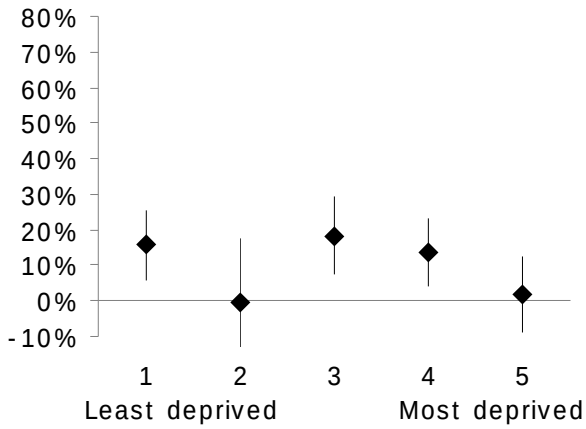


Figure 5f: KSI casualties in adjacent areas



There was some suggestion from point estimates that percentage reductions in numbers of killed and seriously injured (KSI) casualties in 20 mph zones were greater in the least deprived areas (figure 5e). A formal statistical test (not shown) provided weak evidence (p=0.097) that the effect of 20 mph zones on KSI casualties does differ by the level of deprivation of the area.

Figure 5g: Pedestrian casualties in 20 mph zones

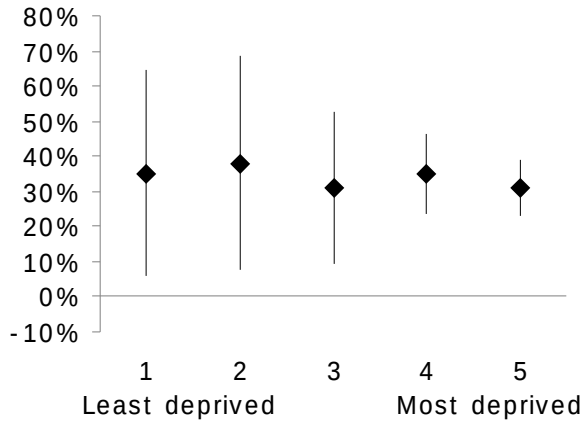
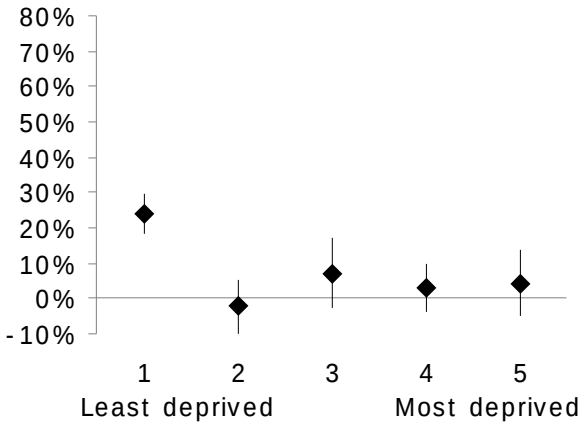


Figure 5h: Pedestrian casualties in adjacent areas



There was no evidence that the estimated percentage reductions in numbers of pedestrian casualties within 20 mph zones differed according to deprivation quintile (figure 5g). There did appear to be a greater reduction in pedestrian casualties within the least deprived parts of London in the areas adjacent to 20 mph zones (figure 5h). However, a formal statistical test (not shown) indicated no evidence for deprivation differences in the reduction of pedestrian casualties in adjacent areas (p=0.374).

Figure 5i: Child pedestrian casualties in 20 mph zones

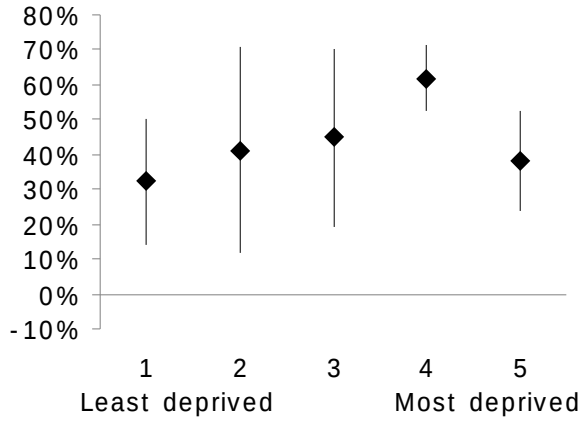
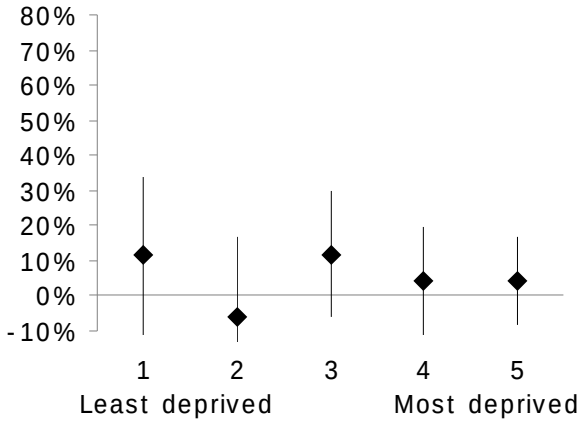


Figure 5j: Child pedestrian casualties in adjacent areas



The point estimates of the percentage reductions in numbers of children injured as pedestrians by deprivation quintile suggest greater reductions on casualties with increased deprivation (figure 5i). However, the confidence intervals for these estimates are wide and overlapping, and a formal statistical test provides no evidence that the effect of 20 mph zones differs by deprivation quintile (p=0.81). There was no evidence to suggest different effects in adjacent areas according to deprivation (figure 5j).

Figure 5k: Cyclist casualties in 20 mph zones

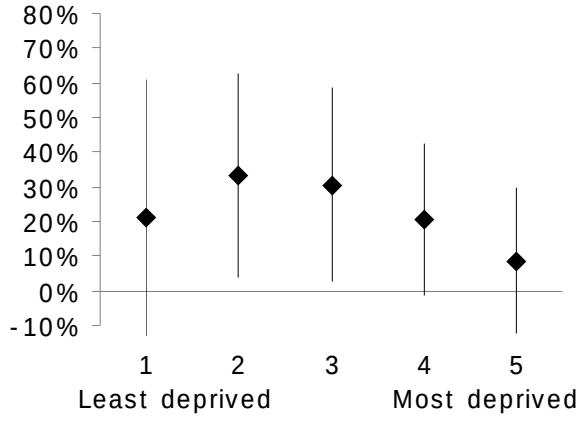
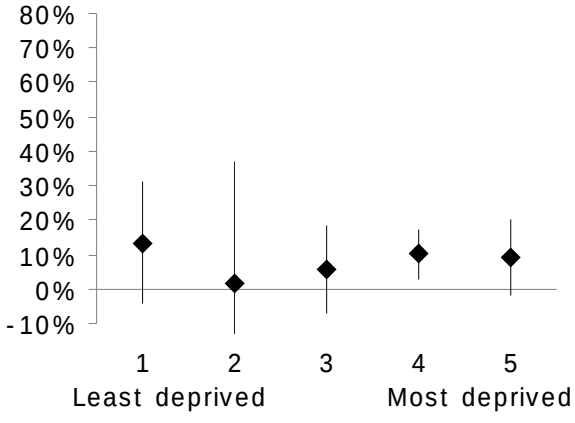


Figure 5l: Cyclist casualties in adjacent areas



The point estimates for the percentage reductions to cyclist casualties suggest smaller effects of 20 mph zones with increased deprivation (figure 5k). However, the numbers of cyclist casualties by deprivation quintile were not sufficient to allow reliable comparisons to be made. There was no evidence to suggest different affects in adjacent areas according to deprivation (figure 5l).

Figure 5m: Powered 2-wheeler casualties in 20 mph zones

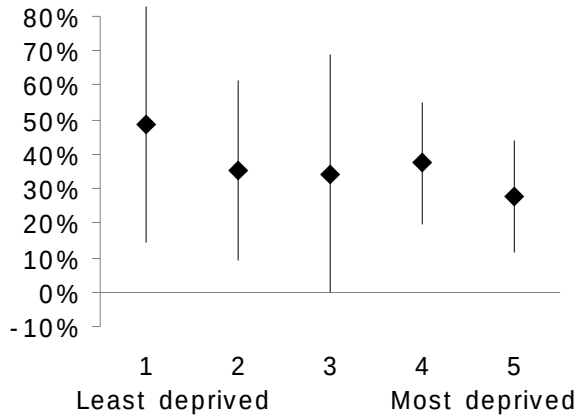
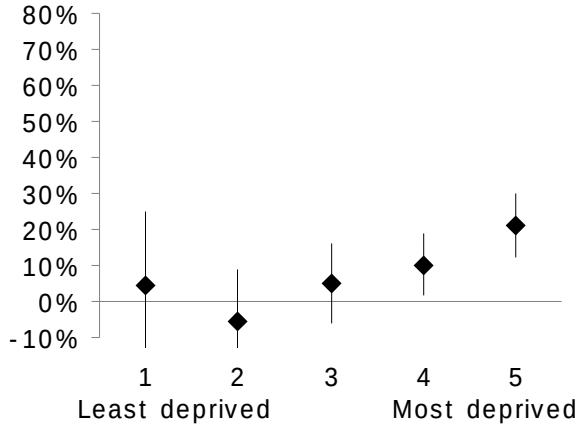


Figure 5n: Powered 2-wheeler casualties in adjacent areas



As with cyclists, point estimates of the reductions to powered 2-wheeler casualties suggest smaller effects of 20 mph zones with increased deprivation (figure 5m), though confidence intervals were wide. In adjacent areas (figure 5n), however, the estimates of the percentage reductions increase with increasing deprivation. A formal statistical test indicated good evidence that the percentage reduction in powered 2-wheeler casualties in adjacent areas is larger in more deprived areas (p=0.004)

Figure 5o: Car occupant casualties in 20 mph zones

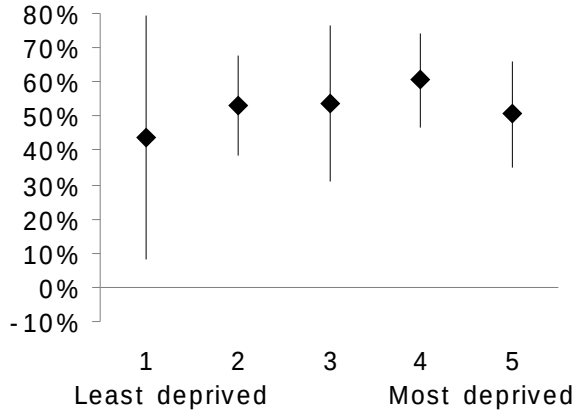
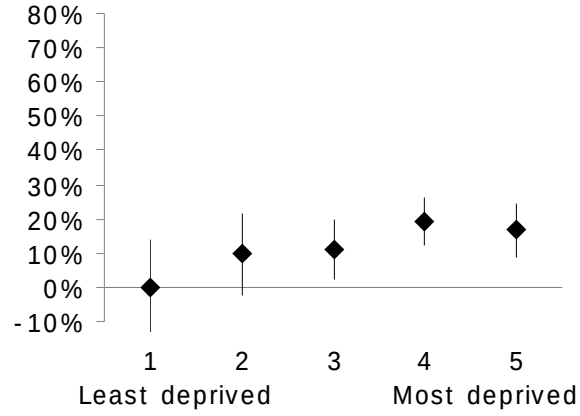


Figure 5p: Car occupant casualties in adjacent areas



The reductions to car occupant casualties in 20 mph zones did not differ substantially by deprivation quintile (figure 5o). However, there was good evidence to suggest a greater reduction in car occupant casualties in areas adjacent to 20 mph zones in more deprived areas (statistical test for trend produced p=0.024; figure 5p).

3.4 What has happened to casualty inequalities by area deprivation over time?

Estimates of the background trend in casualties from the models presented above provide information about the pattern of casualty inequalities over time. In the figures shown below, each black diamond shows the point estimates of the average annual percentage reduction in casualties on all roads in London from 1987 to 2006. For example, all casualties declined by 2.5% each year on all roads in the least deprived areas of London (see figure 6a).

Note again that negative annual reductions shown in the figures below represent average annual *increases* in casualties. For example, powered 2-wheeler casualties (shown in figure 6g) on all roads in the most deprived areas of London increased by 0.2% each year (i.e. a -0.2% reduction in casualties).

Figure 6: Average annual reduction in casualties on all roads by deprivation quintile (1987–2006).

Figure 6a: All casualties

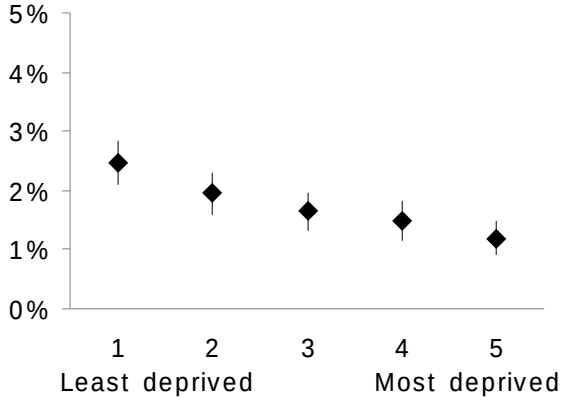
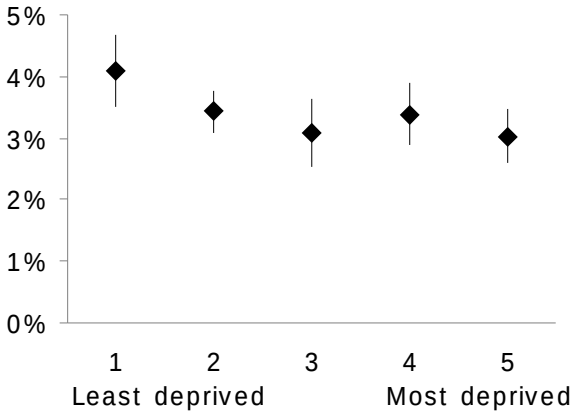


Figure 6b: Child casualties



The point estimates suggest that the average annual decline in all casualties is greater in more affluent areas (figure 6a). A formal statistical test indicated strong evidence that the trend in casualty reduction differed by deprivation quintile ($p<0.001$). When only children are considered (figure 6b) there is good evidence that the average annual reduction in child casualties also differed by deprivation quintile ($P=0.015$)

Figure 6c: KSI casualties

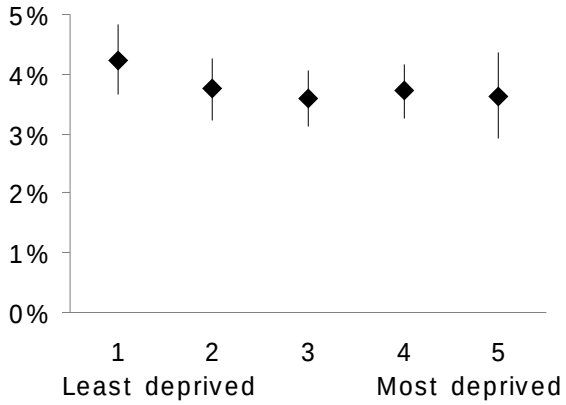
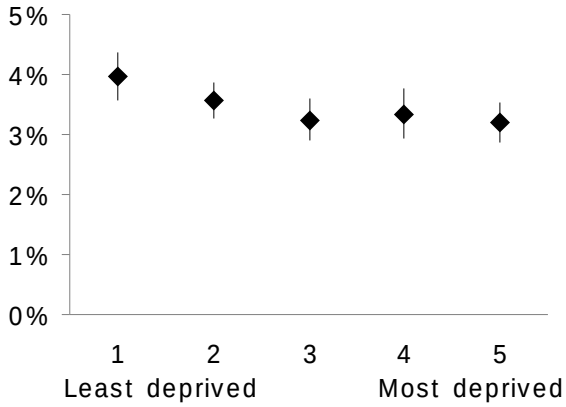


Figure 6d: Pedestrian casualties



There was no evidence that the decline in KSI casualties differed by deprivation quintile (figure 6c). Point estimates suggest that pedestrian casualties declined slightly less in the most deprived areas of London (figure 6d). A formal statistical test indicated good evidence that the average yearly decline in pedestrian casualties differed by deprivation quintile ($p=0.015$).

Figure 6e: Child pedestrian casualties

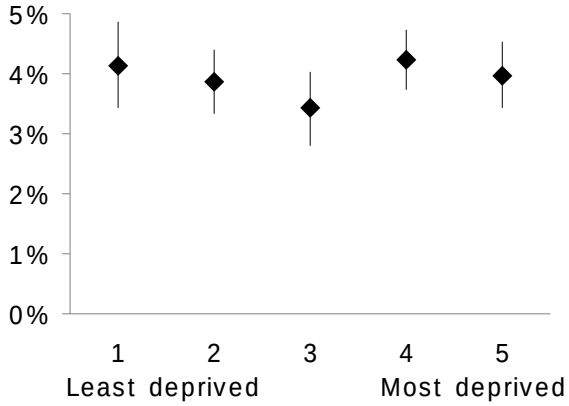
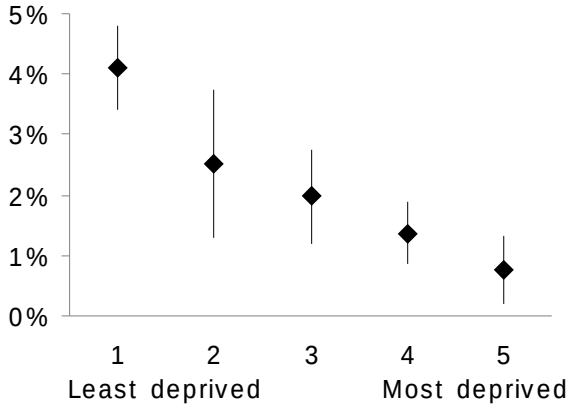


Figure 6f: Cyclist casualties



There was no evidence to suggest that the annual decline in child pedestrian casualties differed by deprivation quintile (figure 6e). Point estimates of the annual percentage reductions in casualties among cyclists suggest that they declined by a greater percentage in more affluent areas (figure 6f). A formal statistical test indicated strong evidence that the annual percentage decline in cyclist casualties differed by deprivation quintile ($p<0.001$).

Figure 6g: Powered 2-wheeler casualties

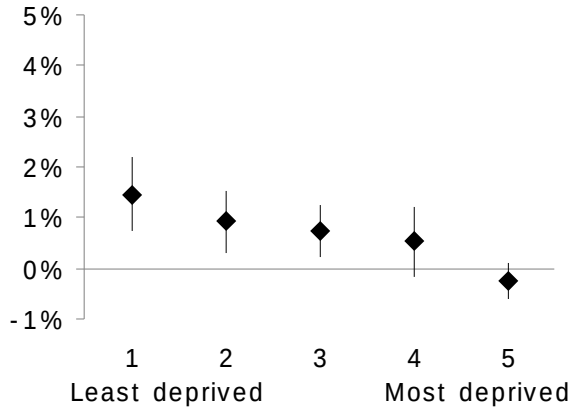
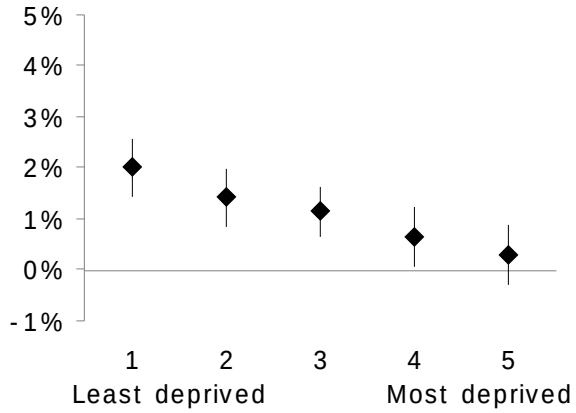


Figure 6h: Car occupant casualties



There was strong evidence to suggest that the average annual decline in powered 2-wheeler casualties ($p<0.001$) and car occupant casualties ($p<0.001$) differed by deprivation quintile (figures 6g and 6h).

Without population estimates in each quintile over time, we cannot reliably determine the pattern of inequalities in casualties over time. However, the majority of these results suggest that casualties in the most affluent areas have experienced greater reductions than casualties in the most deprived areas, suggesting that casualty inequalities have been increasing over time.

3.5 Has the relative effectiveness of 20 mph zones to reduce casualties across deprivation levels changed over time?

The 20 mph Zones and Road Safety in London report suggested that the effect of 20 mph zones on casualties has decreased over time.

We considered percentage reductions in casualties in the most recent period 2000–2006 to determine whether the relative effectiveness of 20 mph zones across deprivation quintiles has changed over time.

In the period 2000-2006 there was no good evidence that reductions in casualties differ across deprivation quintiles (estimated reduction around 20% with wide confidence intervals; figure 7a). Similarly, in areas adjacent to 20 mph zones, there was little evidence that reductions differed by deprivation level (figure 7b).

Figure 7: Percentage reduction in casualties in 20 mph zones and adjacent areas by deprivation of SOA (2000–2006)

Figure 7a: All casualties (2000-2006) in 20 mph zones

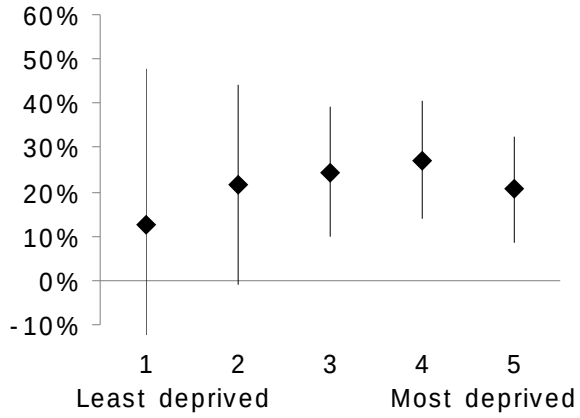


Figure 7b: All casualties (2000-2006) in adjacent areas

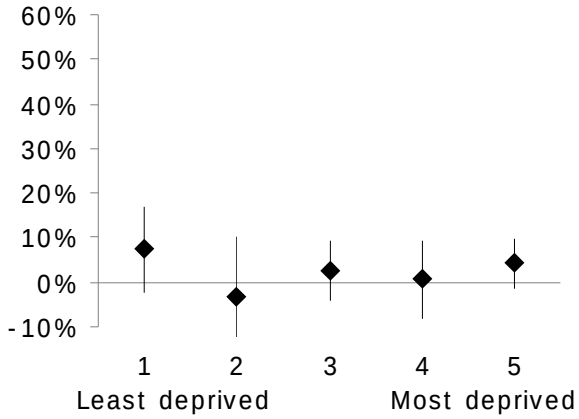
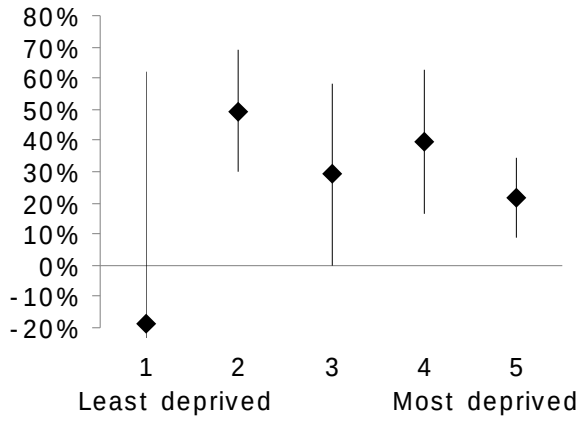
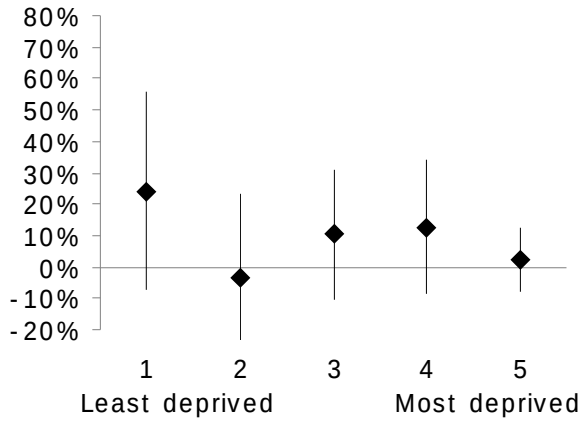


Figure 7c: KSI casualties (2000-2006) in 20 mph zones



(7d): KSI casualties (2000-2006) in adjacent areas



The relative effects by deprivation quintile, of 20 mph zones and adjacent areas, on all casualties (figure 7a), and KSI casualties (figure 7c), were similar to those estimated using the complete data set.

3.6 Do 20 mph zones have a similar effect on casualties of all ethnicities?

The analysis of effects of 20 mph zones by ethnic group excludes data prior to the financial year 1995-1996 because the routine coding of ethnicity of casualties was not introduced until 1995. The models used to derive these estimates assume that background trends decline at a constant rate. Confidence intervals allow for clustering effects by borough. Full results of the models and the numbers of 'White', 'Black' and 'Asian' casualties occurring on 20 mph zone roads, adjacent roads and outside roads can be found in Appendix A.

Figure 8: Percentage reduction in casualties in 20 mph zones and adjacent areas by ethnic group (1996-2006)

Figure 8a: All casualties in 20 mph zones

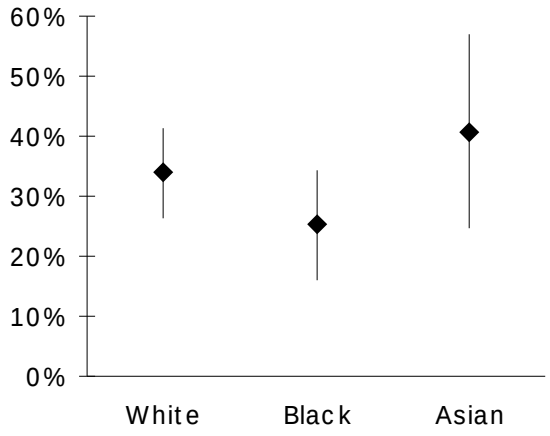
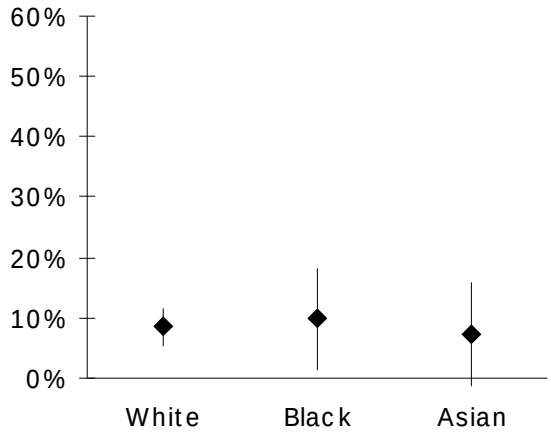


Figure 8b: All casualties in adjacent areas



Overall, 20 mph zones have reduced 'White', 'Black' and 'Asian' casualties (figure 8a).

The estimated reductions in 'White' and 'Asian' casualties are greater than in 'Black' casualties, though confidence intervals are large and overlapping. A test for heterogeneity indicated no evidence that the effect of 20 mph zones differs by ethnicity ($p=0.164$). The reductions in adjacent areas also appear similar across ethnic groups (figure 8b).

Similar results were found when only child casualties were considered (Figures 8c and 8d).

Figure 8c: Child casualties in 20 mph zones

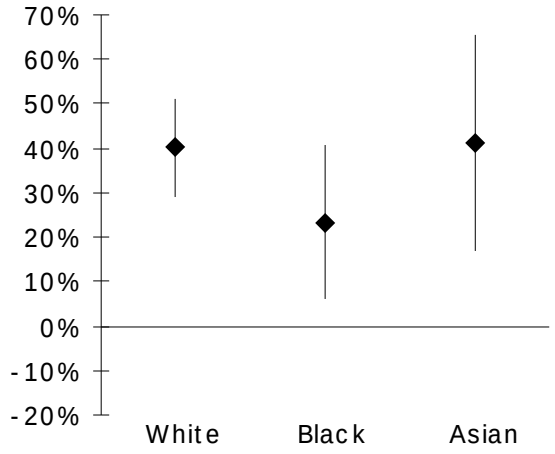


Figure 8d: Child casualties in adjacent areas

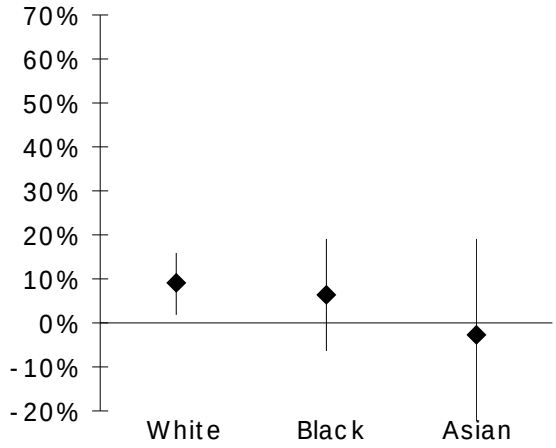


Figure 8e: KSI casualties in 20 mph zones

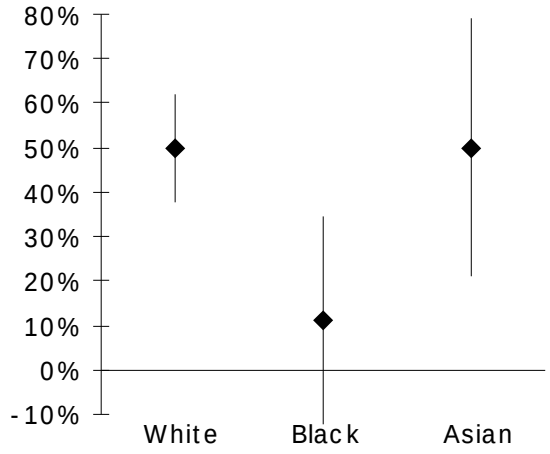
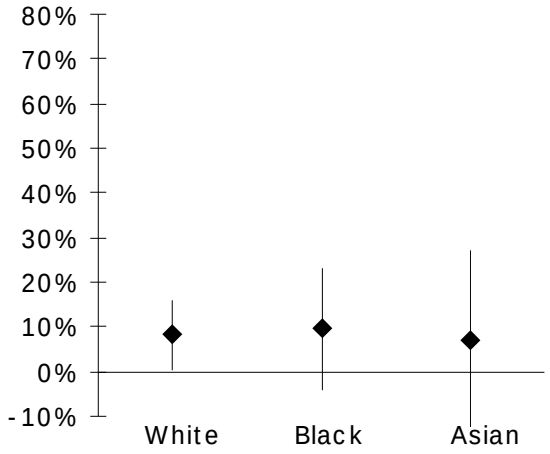


Figure 8f: KSI casualties in adjacent areas



Point estimates suggest larger reductions in 'White' and 'Asian' KSI casualties compared to 'Black' KSI casualties in 20 mph zones (figure 8e). A test for heterogeneity indicated good evidence that the percentage reduction in KSI casualties in 20 mph zones differs by ethnicity (p=0.003).

Reductions in KSI casualties in adjacent areas appear similar across ethnic groups (figure 8f).

Figure 8g: Pedestrian casualties in 20 mph zones

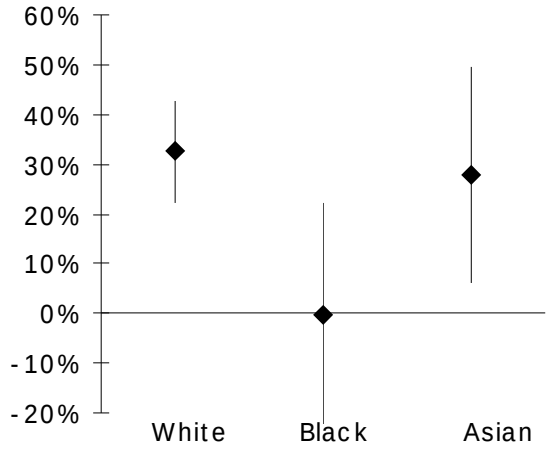
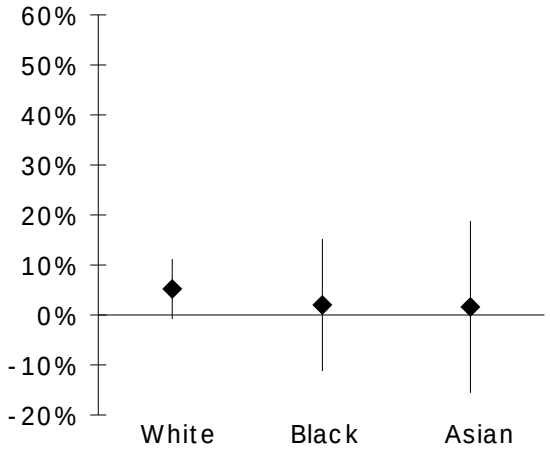


Figure 8h: Pedestrian casualties in adjacent areas



There is some suggestion that 20 mph zones reduce 'Asian' and 'White' pedestrian casualties more than 'Black' pedestrian casualties (figure 8g). The results were similar when only child pedestrians were considered (figure 8i).

Figure 8i: Child pedestrian casualties in 20 mph zones

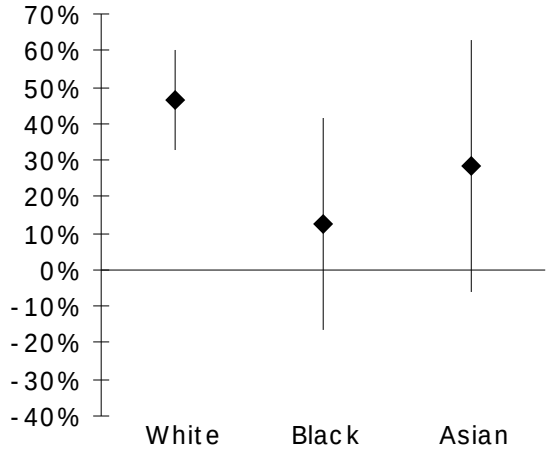
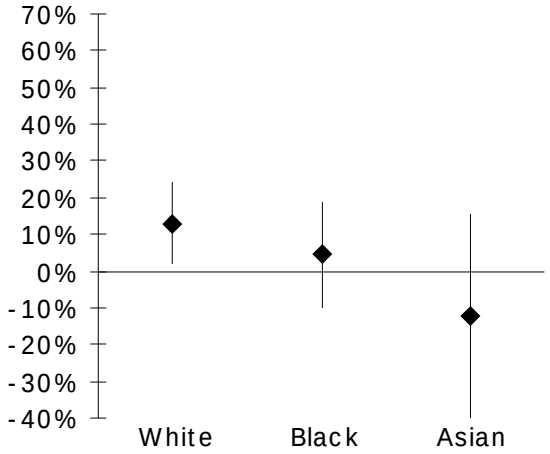


Figure 8j: Child pedestrian casualties in adjacent areas



Formal statistical tests indicated good evidence that the percentage reduction in casualties differs by ethnicity for pedestrians (p=0.012) and child pedestrians (p=0.054).

In adjacent areas, the effect of 20 mph zones on pedestrian casualties appears similar across ethnic groups (figure 8h).

Figure 8k: Cyclists in 20 mph zones

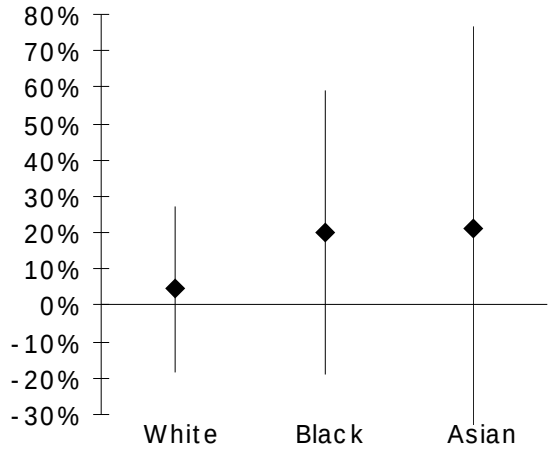
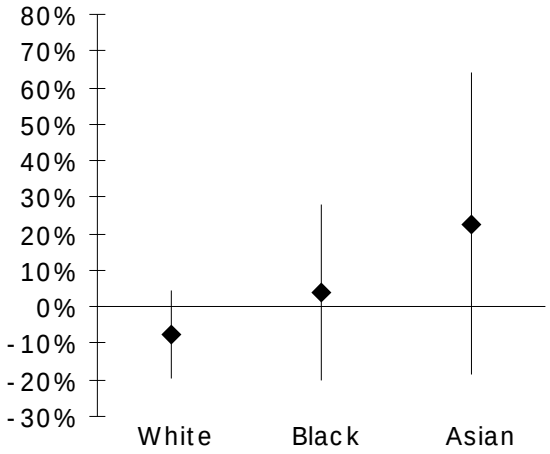


Figure 8l: Cyclists in adjacent areas



There was no evidence that the estimated percentage reductions in numbers of cyclist casualties differed according to ethnic group (figure 8k).

Figure 8m: Powered 2-wheelers in 20 mph zones

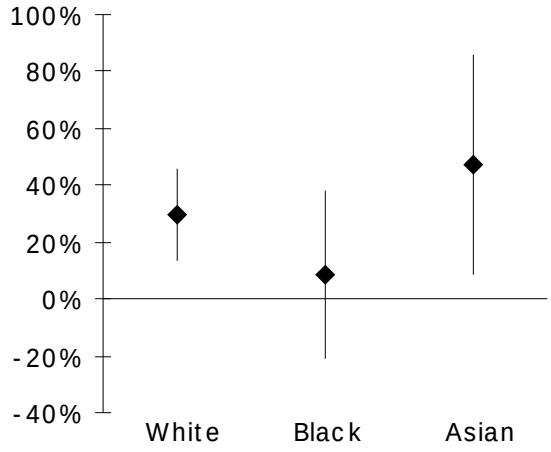
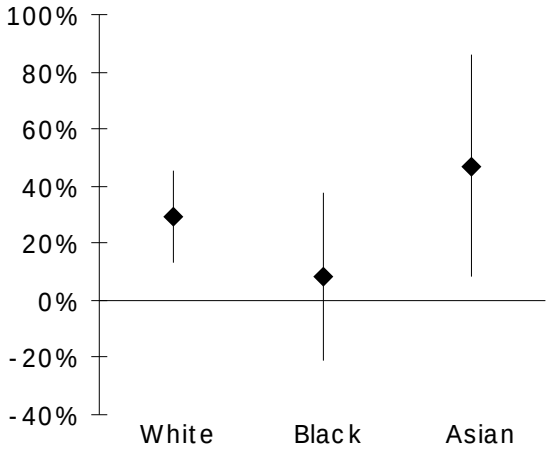


Figure 8n: Powered 2-wheelers in adjacent areas



There was no evidence that the estimated percentage reductions in numbers of powered 2-wheeler casualties differed according to ethnic group (figure 8m – 8n).

Figure 8o: Car occupants in 20 mph zones

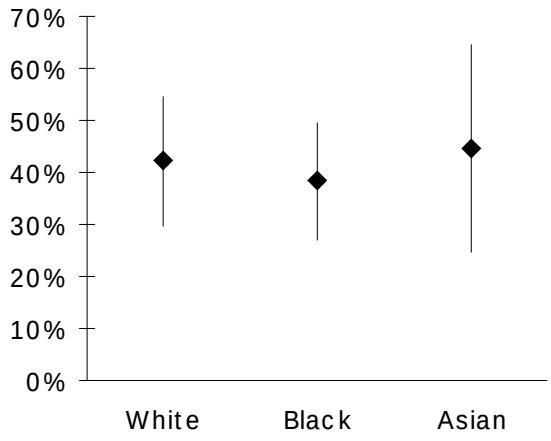
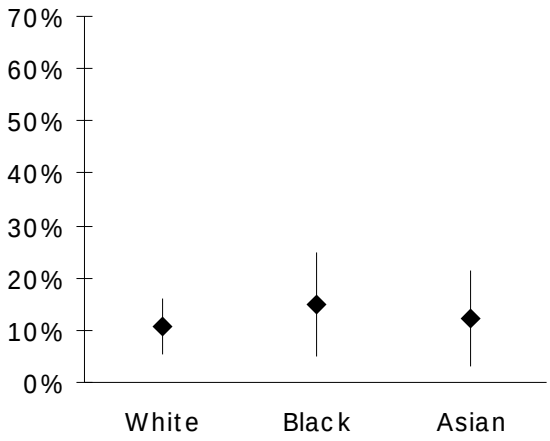


Figure 8p: Car occupants in adjacent areas



There appears to be no difference in the effect of 20 mph zone on 'White', 'Black', and 'Asian' car occupant casualties either within zones or in adjacent areas (figures 8o – 8p).

3.7 Do 20 mph zones impact on the ethnic distribution of casualties?

Our previous research reported differences in casualty risk by ethnicity in London (Steinbach et al 2007). There is also evidence that casualties over the period 2001-2006 have declined at a similar rate across ethnic groups for most road user groups (Malhotra et al 2008). It is not known whether the rate of change in casualties differed by ethnic group before the period 2001-2006, but had 20 mph zones been more effective in reducing casualties in any single ethnic group, then we might expect the distribution of casualties by ethnic group to change after implementation of 20 mph zones.

Table 4: Percentage of casualties on 20 mph zone roads by ethnic group

	Before			After		
	% 'White'	% 'Black'	% 'Asian'	% 'White'	% 'Black'	% 'Asian'
All casualties	67	20	11	64	22	12
Child	55	27	16	53	31	15
KSI	69	19	11	58	30	11
Pedestrian	62	22	15	56	27	15
Child pedestrian	55	28	19	47	35	18
Cycle	77	16	6	80	13	6
Powered 2-wheeler	81	12	4	74	19	4
Car	63	22	13	58	24	16

After implementation of 20 mph zones the distribution of casualties by ethnic group remained relatively similar to that before implementation for most outcome groups. However, the proportion of KSI casualties that was 'Black' increased by over ten percentage points, suggesting that perhaps 20 mph zones are not as effective in reducing 'Black' KSI casualties. The percentage of 'Black' pedestrian casualties increased five percentage points after the introduction of 20 mph zones and the percentage of 'Black' child pedestrians increased 7 percentage points after implementation (table 4).

3.8 What has happened to casualty inequalities by ethnicity over time?

Figure 9 shows the average annual percentage reduction in 'White', 'Black' and 'Asian' casualties on all roads in London from 1996 to 2006.

Again, negative reductions represent an average annual *increase* in casualties. For example, the number of powered 2-wheeler casualties among 'Black' Londoners (figure 9g) increased by 4.7% each year (i.e. -4.7% reduction).

Figure 9: Annual average reduction in casualties in London (1996-2006)

Figure 9a: All casualties

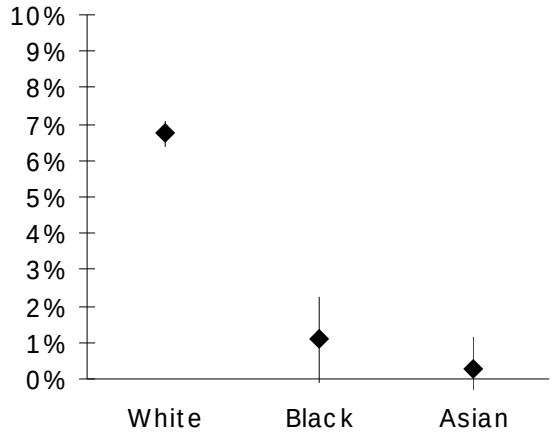


Figure 9b: Child casualties

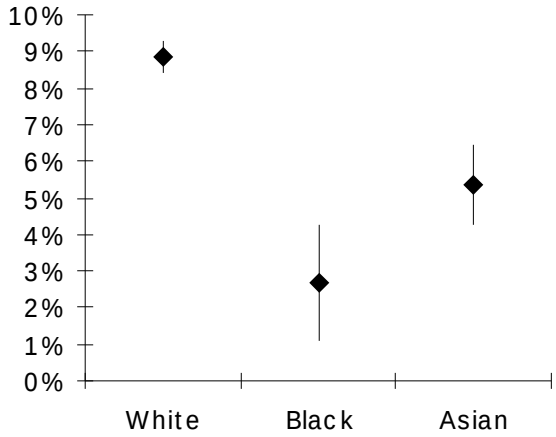


Figure 9c: KSI casualties

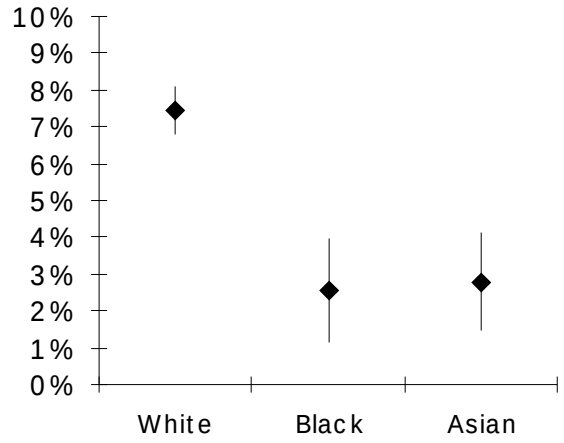


Figure 9d: Pedestrian casualties

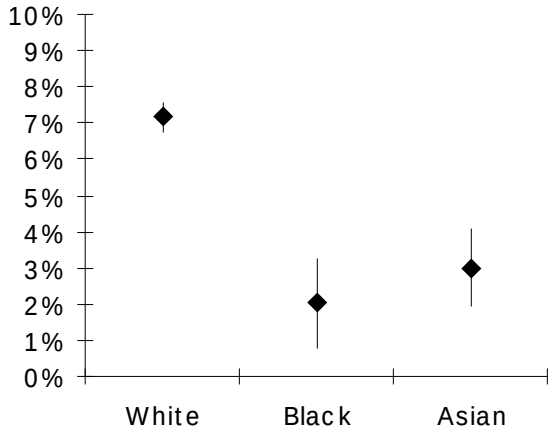


Figure 9e: Child pedestrian casualties

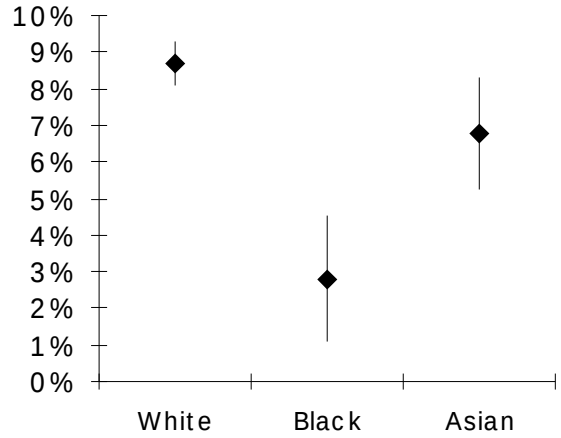


Figure 9f: Cyclist casualties

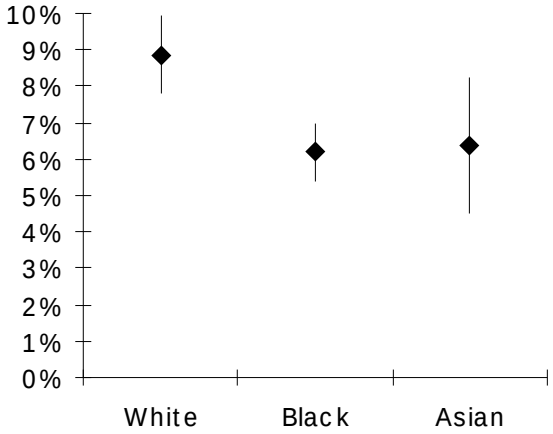


Figure 9g: Powered 2-wheeler casualties

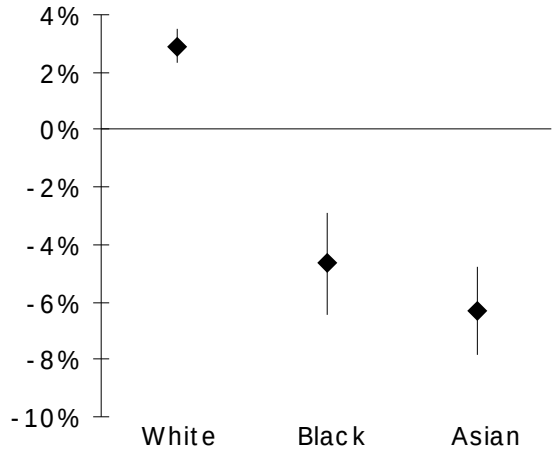
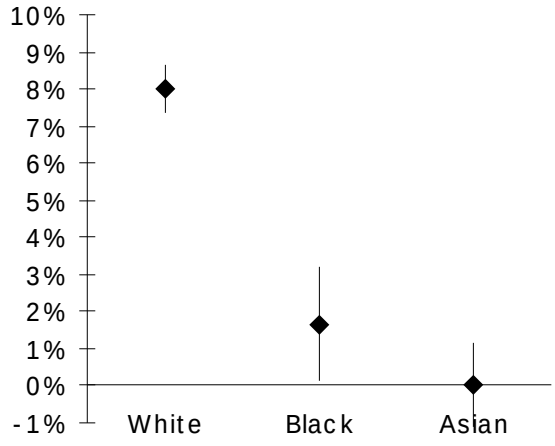


Figure 9h: Car occupant casualties



Across all user groups the estimated annual reductions in 'White' casualties were larger than the reductions to 'Black' and 'Asian' casualties. A test for heterogeneity indicated strong evidence that the annual reduction in casualties differed by ethnic group for all user groups ($p<0.001$). Without accurate population estimates for each ethnic group over time, we cannot conclusively determine the pattern of casualty inequalities over time. However, these results suggest that, 'White' casualties have experienced a greater decline than 'Black' and 'Asian' casualties, suggesting that casualty inequalities have been increasing over time.

3.9 Do ethnicity and deprivation interact?

Our previous work (Steinbach et al, 2007) suggested that the relationship between deprivation and child pedestrian casualties differed by ethnic group. Because of the complex relationship between ethnicity, deprivation and road casualties, we examined evidence for whether effects of 20 mph zones on 'White', 'Black' and 'Asian' casualties differed according to level of area deprivation.

Figure 10: Percentage reduction in casualties in 20 mph zones and adjacent areas by SOA deprivation by ethnic group (1996 – 2006)

Figure 10a: 'White' child pedestrian casualties in 20 mph zones

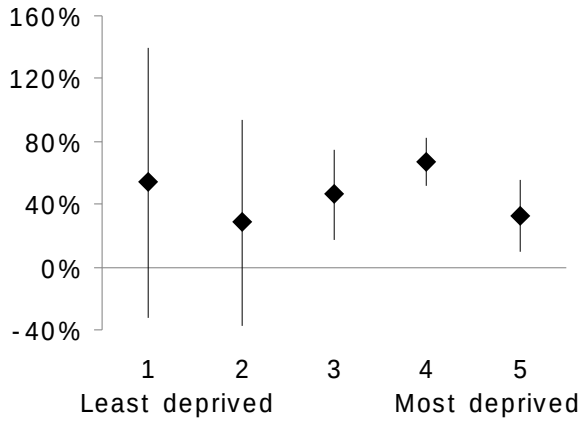
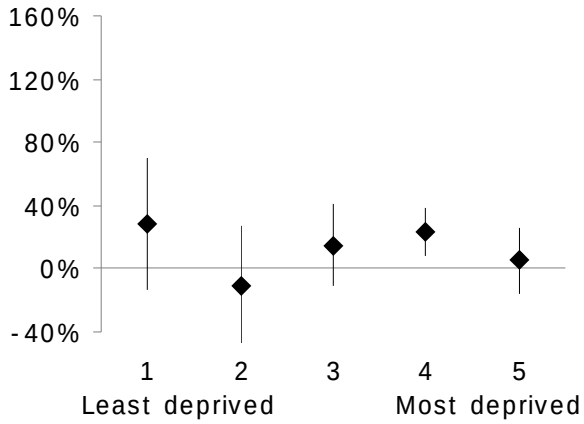


Figure 10b: 'White' child pedestrian casualties in adjacent areas



Among 'White' children there was little evidence that 20 mph zone effects were different according to the level of deprivation (figure 10a – 10b).

Figure 10c: 'Black' child pedestrian casualties in 20 mph zones

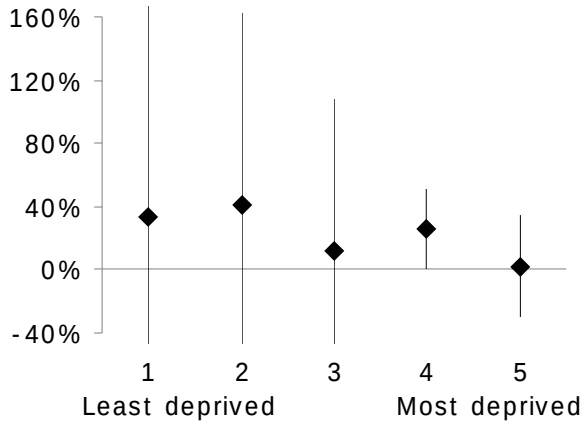
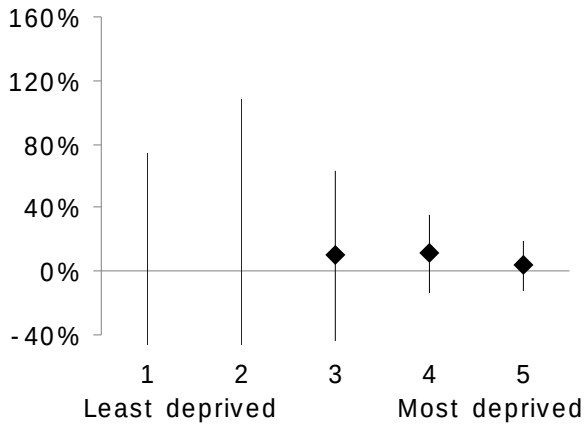


Figure 10d: 'Black' child pedestrian casualties in adjacent areas



The confidence intervals for estimates for the percentage reductions in 'Black' child pedestrian casualties were very wide for each deprivation quintile, and so do not allow for meaningful comparisons (Figure 10c – 10d).

Note: the analysis for 'Asian' child pedestrians has been omitted, as the estimates for effects of 20 mph zones on reducing these casualties in deprivation quintiles were extremely imprecise.

3.10 Has the implementation of 20 mph zones reduced area level inequalities in casualties?

We investigated whether the implementation of 20 mph zones in London has had any effect on casualty inequalities. Using estimates of the effects of 20 mph zones on reducing casualties inside 20 mph zones and in adjacent areas (section 3.3) we modelled the number of casualties in each quintile that would have occurred had 20 mph zones not been implemented. We were able to calculate the number of casualties saved by 20 mph zones on roads inside 20 mph zones, and on roads in areas adjacent to 20 mph zones.

Our results suggest that 20 mph zones have prevented over 4,500 casualties during 1991–2006 (in addition to the downward background trend in casualties on all roads in London). Nearly 2,700 of these casualties have been prevented on roads that are adjacent to 20 mph zones.

Table 5: Actual and predicted casualties by deprivation quintile in 2006

	(A) Length of road km			(B) Actual casualties 2006						(C) Predicted casualties assuming no 20 mph zones		
Deprivation quintile	Total length (km) of road in quintile	% of road in 20 mph zones	% of road in adjacent areas	Casualties on roads in 20 mph zones	*(per km)*	Casualties on adjacent roads	*(per km)*	Casualties on all roads	*(per km)*	On roads in 20 mph zones	On adjacent roads	On all roads
Least Deprived 1	4,535	2	5	40	*0.35*	278	*1.34*	4,154	*0.92*	69	301	4,206
2	4,062	5	8	72	*0.34*	652	*2.02*	6,482	*1.60*	126	673	6,557
3	3,721	8	10	90	*0.29*	1007	*2.60*	6,429	*1.73*	163	1,095	6,590
4	3,165	15	16	155	*0.32*	1512	*3.07*	6,884	*2.18*	302	1,690	7,210
Most Deprived 5	2,652	22	21	334	*0.56*	2716	*4.91*	7,253	*2.73*	541	3,089	7,833
Total	18,135	9	11	691	*0.40*	6,165	*3.14*	31,202	*1.72*	1,201	6,848	32,395

Table 5 shows by deprivation quintile (A) the length of road in kilometres, (B) the actual number of casualties, and (C) the number of casualties predicted had no 20 mph zones been implemented in 2006.

As noted in section 3.1, a larger proportion of roads in the most deprived areas are located in 20 mph zones and adjacent areas (column A).

The number of casualties and casualties per road km are greatest on roads in the most deprived quintile (column B).

The number of casualties on roads in and adjacent to 20 mph zones is larger in the most deprived areas because more 20 mph zones are located in those areas. Overall, the number of casualties per road km in the most deprived quintile is higher than in the least deprived quintile.

The number of casualties that would have been expected in 2006 had no 20 mph zones been implemented anywhere in London are shown in Column C. These have been estimated by inflating the actual number of casualties in 2006 using the deprivation-specific effects of 20 mph zones on reducing casualties, from section 3.3 of this report.

Table 6: Casualties avoided in 2006 in 20 mph zones and adjacent roads by deprivation quintile

		On roads in 20 mph zones			On adjacent roads			On all roads		
Deprivation quintile		N	% of casualties saved	casualties saved per km	N	% of casualties saved	casualties saved per km	N	% of casualties saved	casualties saved per km
Least Deprived	1	29	41.8	0.25	23	7.6	0.11	52	1.2	0.01
	2	54	42.9	0.26	21	3.1	0.06	75	1.1	0.02
	3	73	44.7	0.23	88	8.0	0.23	161	2.4	0.04
	4	147	48.7	0.30	178	10.6	0.36	326	4.5	0.10
Most Deprived	5	207	38.3	0.35	373	12.1	0.68	580	7.4	0.22
Total		510	42.5	0.30	683	10.0	0.35	1,193	3.7	0.07

We therefore estimate that 20 mph zones were associated with a reduction of 1,193 casualties in 2006 (table 6). Almost one half of the total reduction (580 casualties) was in the most deprived quintile. In deprivation quintiles 4 and 5, the implementation of 20 mph zones was associated with a marginally higher reduction in casualties on roads adjacent to 20 mph zones, than in the zones themselves.

Overall, 20 mph zones were associated with a reduction of 7.4% in casualties in most deprived areas, compared with a reduction of 1.2% in casualties in the least deprived areas. This suggests that in the absence of 20 mph zones inequalities in casualties would be greater.

It is important to note here that the roads adjacent to 20 mph zones are more likely to be A roads or roads that tend to be busier and experience more road collisions than smaller roads. These roads may therefore be subject to other remedial measures such as safety (speed) cameras. If these other road safety interventions are disproportionately located on roads adjacent to 20 mph zones, then our model may have overestimated the effects of 20 mph zones on reducing casualties in adjacent areas (section 3.3) and thus have overestimated the numbers of casualties saved on adjacent roads in 2006 (table 6).

Figure 11: Number of actual, predicted and saved casualties in 2006

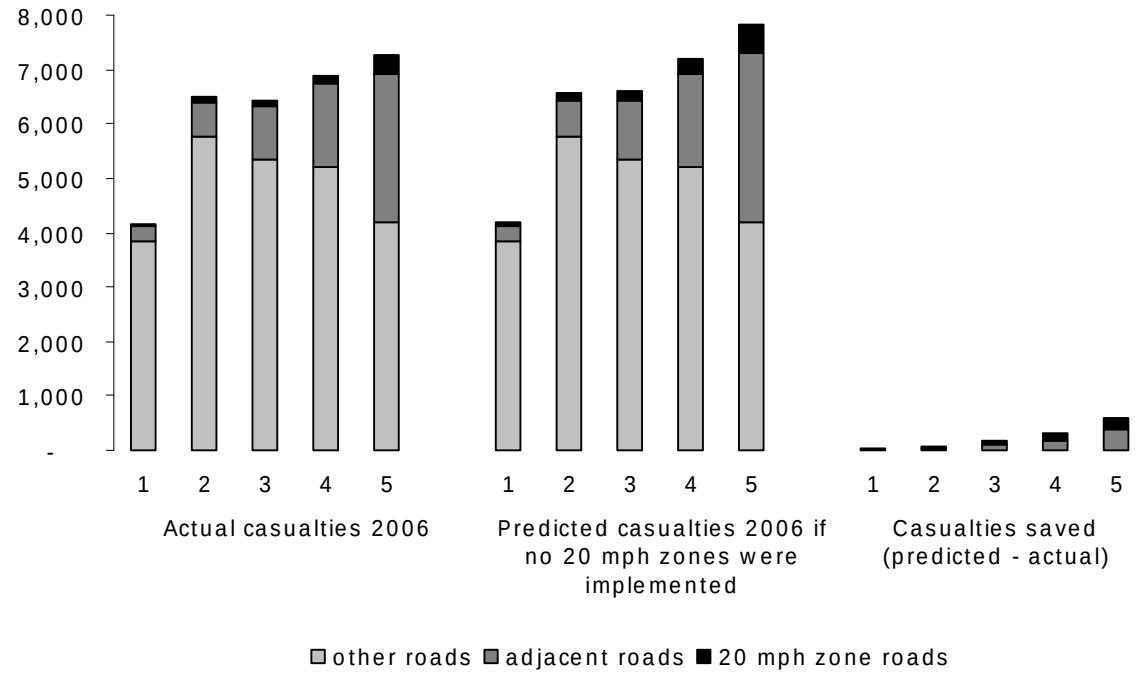


Figure 11 shows the number of casualties on roads inside 20 mph zones, adjacent roads and all other roads that actually occurred in 2006, the number of casualties predicted to have occurred in the absence of 20 mph zones, and the numbers of casualties saved.

In the absence of 20 mph zones we predict that 3,627 more casualties would have occurred on roads in the most deprived quintile compared to roads in the least deprived quintile in 2006 (7,833 casualties in the most deprived quintile minus 4,206 casualties in the least deprived quintile, from column C in Table 5). In reality, 3,099 more casualties occurred on roads in the most deprived quintile compared to roads in the least deprived quintile in 2006 (7,253 casualties in the most deprived quintile minus 4,154 casualties in the least deprived quintile, from column B in Table 5). This suggests that the relative difference in the number of casualties in the most deprived quintile compared to the least deprived quintile is 15% smaller than it would have been in the absence of 20 mph zones.

3.11 Can 20 mph zones be used to reduce casualty inequalities?

The results from Section 3.10 suggest that 20 mph zones have been associated with a greater reduction in casualties in more deprived areas than in less deprived areas. However, since the majority of casualties occur in areas where there are no 20 mph

zones, the impact of 20 mph zones on casualty inequalities overall has been small. To explore what might happen to casualty inequalities if areas covered by 20 mph zones were to be greatly increased, we have estimated the number of casualties by quintile of deprivation that might be saved if 20 mph zones were implemented in other appropriate areas.

When choosing the location of future 20 mph zones, local authorities are able to analyse patterns of casualties in local areas in a detailed way that is not possible in a London-wide study. In our analysis we used SOA boundaries to define areas. We then considered the impact of implementing 20 mph zones on all minor roads in an SOA.

The intervention of implementing 20 mph zones was deemed appropriate for an SOA if:

- the SOA did not already contain any part of a 20 mph zone
- the SOA was classified as 'residential'
- implementing 20 mph zones would be cost effective.

The *20 mph zones and Road Safety in London* report found that the benefits of a 20 mph zone would outweigh the costs over a 10-year time horizon if an area experienced over 0.7 casualties per road kilometre per year. We calculated the average number of casualties occurring on minor roads within each SOA from 2004–2006 and selected those SOAs where the average number of casualties was greater than 0.7 per year per kilometre.

Table 7: Eligibility of SOAs for 20 mph zones by deprivation

Deprivation quintile		Number of SOAs	Ineligible: SOA already contains part of a 20 mph zone	Ineligible: SOA is not residential	Ineligible: Less than 0.7 casualties per kilometre	Eligible zones
Least Deprived	1	953	118	59	652	124
	2	954	187	85	495	187
	3	952	245	102	410	195
	4	953	391	81	282	199
Most Deprived	5	953	523	45	210	175
Total		4,765	1,464	372	2,049	880

A total of 880 SOAs (18%) met our criteria. London-wide, 1,464 (31%) SOAs already contain part of a 20 mph zone. Over half of the SOAs in the most deprived quintile of London already contain part of a 20 mph zone (table 7).

To estimate the potential number of casualties saved in an SOA by 20 mph zones by deprivation quintile, we applied estimates of the effect of 20 mph zones 2000-2006 (from

section 3.5) to the average number of casualties (2004-2006) occurring on minor roads in the SOA.

Table 8 shows that if 20 mph zones were implemented on all minor roads within eligible SOAs, nearly 700 casualties would be expected to be saved the following year.

Table 8: Casualties saved in SOAs eligible for zone extensions

Deprivation quintile		Number of SOAs	Casualties per year before implementation	Casualties per year after 20 mph zone implementation	Casualty savings
Least Deprived	1	124	567	494	72
	2	187	730	572	158
	3	195	665	503	163
	4	199	722	526	196
Most Deprived	5	175	533	424	109
Total		880	3,217	2,519	699

Table 9: Implications for London, all possible 20 mph zone extensions

			Before 20 mph zone extensions		After 20 mph zone extensions	
Deprivation quintile		Number of SOAs	Average number of casualties per year 2004-2006	Ratio to Q1	Number of casualties per year	Ratio to Q1
Least Deprived	1	953	1,625	-	1,552	-
	2	954	2,152	1.32	1,994	1.28
	3	952	2,041	1.26	1,879	1.21
	4	953	2,108	1.30	1,912	1.23
Most Deprived	5	953	1,905	1.17	1,796	1.16
Total		4,765	9,831	-	9,133	-

Table 10: Implications for London, 20 mph zone extensions in quintiles 4 and 5 only

			Before 20 mph zone extensions		After 20 mph zone extensions	
Deprivation quintile		Number of SOAs	Average number of casualties per year 2004-2006	Ratio to Q1	Number of casualties per year	Ratio to Q1
Least Deprived	1	953	1,625	-	1,625	-
	2	954	2,152	1.32	2,152	1.32
	3	952	2,041	1.26	2,041	1.26
	4	953	2,108	1.30	1,912	1.18
Most Deprived	5	953	1,905	1.17	1,796	1.11
Total		4,765	9,831	-	9,526	-

While extending 20 mph zones to all eligible areas (table 9) will likely decrease numbers of casualties, 20 mph zone extensions are unlikely to play a large role in mitigating casualty inequalities. If 20 mph zones are targeted in appropriate areas in quintiles 4 and 5 only (table 10), it appears that casualty inequalities will decrease.

If we further limit appropriate areas to high casualty SOAs (more than 10 casualties in the last 3 years), only 377 SOAs would meet our criteria, and relatively few of those are among the most deprived areas in London (table 11). Implementing 20 mph zones in these areas appears to have little effect on casualty inequalities between the most and least deprived areas in London (table 12).

Table 11: Casualties saved in high casualty SOAs eligible for zone extensions

Deprivation quintile		Number of SOAs	Casualties per year	Casualties per year after 20 mph zone implementation	Casualty savings
Least Deprived	1	80	453	395	58
	2	89	491	385	106
	3	66	372	281	91
	4	88	470	342	128
Most Deprived	5	54	284	225	58
Total		377	2,069	1,165	441

Table 12: Implications for London, 20 mph zone extensions in high casualty areas

			Before 20 mph zone extensions		After 20 mph zone extensions	
Deprivation quintile		Number of SOAs	Average number of casualties per year 2004-2006	Ratio to Q1	Number of casualties per year	Ratio to Q1
Least Deprived	1	953	1,625	-	1,567	-
	2	954	2,152	1.32	2,046	1.31
	3	952	2,041	1.26	1,950	1.24
	4	953	2,108	1.30	1,980	1.26
Most Deprived	5	953	1,905	1.17	1,847	1.18
Total		4,765	9,831	-	9,391	-

4. Further Analysis

4.1 Is it possible to look at the effect 20 mph zones have had on inequalities in casualty rates?

Introduction

The results from section 3.1 indicate that in 2000, 20 mph zones were distributed fairly evenly across deprivation quintiles. By 2006, however, 20 mph zones were disproportionately located in the more deprived areas in London. If the introduction of 20 mph zones over this period reduced inequalities, we would expect that the rate of decline in casualty rates between 2000 and 2006 would be greater in the more deprived areas. To test whether declines in casualty rates differ by deprivation quintile, we used child pedestrian casualties (as recommended in *Deprivation and Road Safety in London* when monitoring the relationship between deprivation and casualties).

Methods

In order to obtain a population denominator to derive casualty rates, casualties were linked to the SOA in which the collision occurred. Previous research (Edwards et al, 2007) suggested that this linkage is most appropriate for child pedestrians, as they tend to be injured close to home. We considered casualty rates in two time periods: 1995–2000 and 2001–2006. We used the population resident in each SOA (from the 2001 census) as the denominator to estimate casualty rates by deprivation quintile for all child pedestrians.

To estimate casualty rates by ethnic group we estimated the numbers of 'White', 'Black' and 'Asian' children (ages 0–15 years) living in each SOA, by multiplying the total numbers of children (ages 0–15 years) living in each SOA (from 2001 census), by the percentages of residents of all ages that are 'White', 'Black', or 'Asian' (also from 2001 census). These estimates of SOA-level ethnic group populations were then scaled to ensure that our estimates of ethnic-specific borough populations were equal to those in the census (Steinbach et al 2007).

Results

Pedestrian casualty rates per 100,000 children living in all areas of deprivation declined by about 30% between 1996–2000 and 2001–2006 (table 13a). Child pedestrian KSI casualties declined by between 28% and 40%. The rate ratios suggest that child pedestrian casualty rates and KSI casualty rates declined at a similar rate across the deprivation quintiles.

Table 13a: Child pedestrian casualty rates per 100,000 children

Casualty type	Quintile of socio-economic deprivation		Road casualty rate per 100,000 population		Rate ratio 1996-2000/ 2001-2006
			1996-2000	2001-2006	
Child pedestrians	Least Deprived	1	93.0 (88.0, 98.3)	63.5 (59.7, 67.5)	0.68 (0.63, 0.74)
		2	150.1 (143.5, 156.9)	101.8 (96.9, 107.0)	0.68 (0.64, 0.73)
		3	181.1 (174.0, 188.4)	133.0 (127.5, 138.8)	0.73 (0.69, 0.78)
		4	209.6 (202.4, 217.1)	147.5 (141.9, 153.2)	0.70 (0.67, 0.74)
	Most Deprived	5	223.0 (216.0, 230.2)	155.8 (150.5, 161.3)	0.70 (0.67, 0.73)
Child pedestrians KSI	Least Deprived	1	19.7 (17.4, 22.2)	14.3 (12.5, 16.2)	0.72 (0.61, 0.86)
		2	35.6 (32.4, 39.0)	21.3 (19.1, 23.7)	0.60 (0.52, 0.69)
		3	39.5 (36.2, 43.0)	27.1 (24.6, 29.8)	0.69 (0.60, 0.78)
		4	46.2 (42.9, 49.8)	29.6 (27.2, 32.2)	0.64 (0.57, 0.72)
	Most Deprived	5	49.5 (46.3, 53.0)	30.3 (28.0, 32.8)	0.61 (0.55, 0.68)

Table 13b: Child pedestrian casualty rates per 100,000 children, by ethnicity and deprivation

Casualty type	Quintile of socio-economic deprivation		Road casualty rate per 100,000 population		Rate ratio 1996-2000/ 2001-2006
			1996-2000	2001-2006	
'White' child pedestrians	Least Deprived	1	90.0 (84.4, 95.8)	53.1 (49.2, 57.2)	0.59 (0.53, 0.65)
		2	147.7 (139.7, 156.0)	90.5 (84.8, 96.5)	0.61 (0.56, 0.67)
		3	175.5 (166.5, 184.8)	107.9 (101.4, 114.6)	0.61 (0.57, 0.67)
		4	208.0 (198.3, 218.1)	116.3 (109.7, 123.2)	0.56 (0.52, 0.60)
	Most Deprived	5	233.0 (222.1, 244.4)	132.9 (125.4, 140.8)	0.57 (0.53, 0.61)
'Black' child pedestrians	Least Deprived	1	157.0 (125.4, 194.1)	155.5 (126.6, 188.9)	0.99 (0.74, 1.32)
		2	188.7 (166.3, 213.3)	144.4 (126.5, 164.1)	0.77 (0.64, 0.92)
		3	197.6 (179.8, 216.7)	193.8 (177.7, 210.9)	0.98 (0.87, 1.11)
		4	206.3 (191.7, 221.7)	182.4 (169.9, 195.6)	0.88 (0.80, 0.98)
	Most Deprived	5	195.6 (184.7, 207.0)	154.3 (145.5, 163.6)	0.79 (0.73, 0.86)
'Asian' child pedestrians	Least Deprived	1	50.6 (39.6, 63.7)	42.2 (33.0, 53.1)	0.83 (0.60, 1.16)
		2	92.5 (80.2, 106.1)	60.0 (51.0, 70.1)	0.65 (0.53, 0.80)
		3	122.2 (108.7, 137.0)	77.4 (67.6, 88.2)	0.63 (0.53, 0.75)
		4	134.1 (120.7, 148.7)	99.6 (89.0, 111.1)	0.74 (0.64, 0.86)
	Most Deprived	5	137.8 (126.1, 150.2)	93.9 (85.1, 103.3)	0.68 (0.60, 0.78)

Results stratified by ethnic group and deprivation (table 13b) suggest that, although the decrease over time in casualties has been slightly greater for 'White' children than for 'Black' or 'Asian' children, there is no clear evidence that the relative deprivation patterns of change differ by ethnic group.

Conclusions

Although local authorities have located 20 mph zones preferentially in deprived areas after 2000, there is little discernable difference in the declines in casualty rates across deprivation quintiles between the two periods 1996–2000 and 2001–2006. This is consistent with evidence from Section 3.10 which showed that casualties within 20 mph zones represent a small proportion of overall casualties in London as a whole. Thus, even with clear targeting, and similar relative impact of 20 mph zones across all deprivation quintiles (Section 3.3), the potential for reducing inequalities remains limited.

4.2 Can we use a before and after analysis to monitor the relationship between 20 mph zones and casualty inequality?

Introduction

Traditionally, the casualty reduction effects of 20 mph zones have been estimated using a 'before and after' methodology. While we feel the time series regression analysis is a more robust method to use to investigate the relationship between 20 mph zone implementation and casualty inequalities, it is a relatively lengthy and computationally intensive process. We therefore investigated whether a simple 'before and after' analysis would provide similar results to the time series regression results reported in section 3.3.

Methods

In the before and after analysis we compared the number of casualties per year three years before the 20 mph zone was implemented to the number of casualties per year three years after implementation of the zone. These estimates were then adjusted to take into account background changes in casualties on roads outside zones. We calculated trends on outside roads using only B and unclassified roads that have never been inside or adjacent to a 20 mph zone.

We calculated a different trend (percentage change in casualties) for each year using the total number of casualties on outside roads in the three previous years compared to the number of casualties in the three subsequent years. For example, to calculate the trend on outside roads in 1999, we calculated the percentage change in the number of casualties that occurred on outside roads between 1996 and 1998 compared to the number of casualties that occurred between 2000 and 2002. Background changes were calculated separately for each deprivation quintile.

Each 20 mph zone was assigned an IMD score based on the average IMD score of all road segments within the zone weighted by length. Using the before and after method we investigated the effect of 20 mph zones by deprivation quintile on all casualties and KSI casualties. Notably, the before and after analysis only considered 20 mph zones implemented between 1991 and 2003, because three years of 'after' data was not available in later years. Estimates from section 3.3, however, were based on data through 2006.

Results

The results of the before and after analysis show:

(i) estimates for the percentage reduction in casualties and KSI casualties are smaller than those derived from the time series regression analysis of data for the whole time period (Section 3.3);

(ii) point estimates for the percentage reduction in all casualties and KSI casualties in the most deprived quintile of deprivation are relatively small, though there is considerable statistical imprecision in the estimates.

Table 14: Percentage reduction in casualties comparing 3 years before to 3 years after 20 mph zone implementation

	Least Deprived				Most Deprived
Outcome	1	2	3	4	5
Average effect 1991-2003					
All casualties	23	34	32	34	11
KSI casualties	30	-3	42	35	4
Average effect 2000-2003					
All casualties	16	35	28	26	12
KSI casualties	31	8	40	25	11
Average effect in high collision zones					
All casualties	30	24	33	35	15
KSI casualties	43	25	38	36	15

In the more recent time period, the point estimates of percentage reduction in all casualties are lowest for the most deprived and the least deprived quintiles. The estimates of percentage reduction in KSI casualties are lowest for quintile 2 and the most deprived quintile.

Conclusion

Estimates based on the 'before and after' analysis, which uses data for only three years either side of the implementation date, appear smaller and considerably less stable than the statistically more robust estimates based on analysis of data for the whole period (time series regression). This in part reflects issues of small numbers, with year to year variations and stratification into five deprivation strata. Although the simpler method of analysis provides a broad indication of the effect of 20 mph zones, the evidence should be used cautiously, especially for assessing *differentials* of effect across deprivation strata.

5. Discussion

This report provides an analysis of the effect of 20 mph zones on socio-economic and ethnic differentials in casualty patterns in London. Its evidence is clear in suggesting that 20 mph zones are similarly effective in reducing casualties in deprived and affluent areas, but that their targeting at deprived areas (and the inherently higher casualty rates in deprived populations) has made some contribution to mitigating socio-economic differentials in road casualties. Based on the number of casualties 'saved' by implementing 20 mph zones, we estimate that they have reduced the gap between the number of casualties in the most and least deprived quintiles of SOA by around 15%. However, 20 mph zones do not appear to have addressed ethnic differences in casualty rates. Before discussing the policy implications of the findings, we highlight some strengths and limitations of the analysis in the light of previous research.

Methodological issues

To the best of our knowledge, this is the first detailed analysis of the effect of 20 mph zones on inequalities in casualties. The only previous study within the UK was based on a 'natural experiment' design, and was hampered by lack of implementation dates for traffic calming measures (Jones et al 2005). With data on implementation dates for 96% of 20 mph zones, we have used the most robust methods possible to evaluate the effect of implementing zones on inequalities in area level deprivation and between broad ethnic groups. However, as discussed in the introduction to this report, assessing the effect of a single road safety intervention is a challenge.

First, it is impossible to control for the effects of simultaneous road safety initiatives that might confound the analysis. This is a particular issue for the areas adjacent to 20 mph zones, which are likely to include major roads, and possibly be subject to other casualty reduction initiatives (e.g. installation of safety/speed cameras) implemented at the same time.

Second, road user behaviour is complex, and likely to change in response to engineering interventions. As 20 mph zones are introduced, pedestrian behaviour in particular is likely to change, as residents may feel safer and more confident in travelling around and playing in their local environment. These changes may differ across the groups we are comparing (e.g. different local areas or different ethnic groupings).

It should be noted that our main analyses were based on trends in casualty *numbers* rather than casualty rates as there are no appropriate population denominators on which

to base rate calculations. Nonetheless, only very large, selective and unlikely patterns of population change over time would materially alter any of the basic conclusions.

We were unable to assess the historical effect of 20 mph zones and the implications of extending 20 mph zones on ethnic inequalities. Ethnic populations are likely to have changed over time and estimates of population changes by ethnicity are not available at a small area level.

STATS19 data are subject to under-reporting and under-recording. If under-reporting and under-recording are more or less likely in a 20 mph zone compared to outside roads then estimates of the effects of 20 mph zones may be biased. Further, our results may also be affected if under-reporting and under-recording disproportionately affect some ethnic groups, differ by area deprivation, or have changed over time.

Previous research identified differences in the relationship between deprivation and road casualties by ethnic group. Specifically, for 'White' and 'Asian' groups, living in more deprived areas increased casualty risk, whereas for 'Black' groups, there was no apparent relationship between area deprivation and casualty risk (Steinbach et al 2007). The numbers of casualties were too small to investigate the effect of 20 mph zones on the complex relationship between ethnicity, deprivation, and road casualties. Small numbers of casualties also precluded any analysis of differential effects on deprivation/ethnicity by inner and outer London and residential status.

Implications for road safety policy

Our previous research suggested that reducing the speed and volume of traffic was likely to reduce inequalities in casualties. We hypothesised that a key contributor to both socio-economic and ethnic inequalities was a difference in exposure, in that those groups with highest rates of casualties were likely to be spending more time as vulnerable road users, for instance in walking or cycling, or by 'hanging out' near roads in leisure time. In the short to medium term, implementing 20 mph zones was likely, then, to reduce the effects of higher exposure by reducing the relative risk of being exposed, assuming that they did not increase time exposed by altering behaviour. In the longer term, reducing the speed and volume of traffic might alter the balance of travel modes used, such that people walk and cycle more as it becomes safer, and more pleasant to do so. Given the evidence of a 'critical mass effect' (Jacobsen 2003), whereby walking and cycling become safer as more people do so, this could over time potentially reduce inequalities as the relative risks of different transport modes become more equal.

Assessing the impact of 20 mph zones on inequalities in road traffic casualties in London involves identifying both the effectiveness of policy implementations (i.e., have 20 mph zones been sited where they are most likely to address inequalities?), and the effectiveness of the intervention (i.e. whether implemented 20 mph zones have differential effects on different population groups). Across London, 20 mph zones have been implemented in areas where they are most likely to reduce inequalities, given that they have been increasingly targeted at those high collision areas which are more likely to be in deprived areas. Given the association with proportion of minority ethnic population and deprivation, the proportion of ethnic minority population living within a 20 mph zone has also increased. In principle, then, these policies have targeted those populations most at risk of road casualties.

There was little evidence of deprivation differentials in the *relative* impact of 20 mph zones on any of the main categories of casualties examined. This held true for the more recent years, with a higher density of 20 mph zones in deprived areas. But 20 mph zones were clearly targeted at deprived areas, and more deprived populations have higher baseline casualty rates. In consequence, the number and proportion of casualties prevented appears appreciably greater for the more deprived quintiles. However, given the small contribution of casualties within 20 mph zones to all casualties in London, the effect of 20 mph zones on socio-economic differentials has been correspondingly small.

Our previous research on area level deprivation inequalities suggested that there had been little change in child pedestrian inequalities over time (Edwards et al 2007). When we looked at the background trends in casualty reduction in child pedestrians, we found similar results. However, for the majority of other outcomes, we found that numbers of casualties were falling faster in the least deprived areas. This suggests that overall inequalities in casualties in London were widening over the period of this. To have reduced inequalities, 20 mph zones would therefore have had to either be *more* effective in more deprived areas, or be sited disproportionately in deprived areas. The analysis of the impact of 20 mph on casualties across deprivation levels in 2006 suggested that 20 mph zones reduced more casualties in the more deprived areas, both within the 20 mph zones, and on adjacent roads. While overall the impact of 20 mph zones on reducing socio-economic inequalities in 2006 appeared minimal, we can infer that the implementation of 20 mph zones (and the greater implementation of those 20 mph zones in deprived areas) has probably mitigated an underlying trend of increasing area level inequality.

Our previous research on ethnicity and road safety (Steinbach et al 2007) noted the difficulties of targeting effective road safety interventions by ethnicity, given that road

engineering is locality based. It was less likely, then, that 20 mph zones would have a demonstrable effect on inequalities between ethnic groups, although reducing the speed and volume of traffic was likely to improve road safety for all Londoners. This study found that 20 mph zones had increased safety for all Londoners, but for all user groups the estimated reductions in casualties were higher for 'White' road users, and 20 mph zones appeared relatively less successful in reducing the numbers of 'Black' KSI casualties compared with other groups. In terms of addressing the observed higher rates of casualties in London's 'Black' minority ethnic groups, it does not appear that 20 mph zones are likely to have had an effect. Over the 1996–2006 period, 'White' casualties in all user groups experienced a steeper decline than 'Black' and 'Asian' casualties. Although there was no evidence that 20 mph zones had a differential effect on the three ethnic groupings for all casualties, there was evidence that they had reduced pedestrian causalities and KSI more in 'White' and 'Asian' than in the 'Black' groups, thus potentially exacerbating existing ethnic inequalities.

It is difficult to speculate on why 20 mph zones may be less effective in reducing pedestrian casualties and those KSI in some ethnic groups. The causal pathways between road engineering and casualty risk are complex, with measures to reduce traffic speed and volume likely to increase exposure, if roads are, or are perceived as, safer, as well as potentially reducing the risk of injury in a collision. Potential explanations of the differential impact across ethnic groups might, then, involve different patterns of exposure. If, for instance, 'Black' pedestrians have significantly more exposure (through travel or leisure) to traffic, or are more likely to walk or play in traffic calmed streets than those in other ethnic groups, the reductions in casualties may be more difficult to off-set with reduced traffic speed. Similarly, if there are differences in behaviour or conspicuousness (i.e. how easily road users can be seen), 20 mph zones may have a smaller effect. This study could not evaluate the impact of 20 mph zones on 'road danger', or on perceived road danger, and we could not therefore investigate whether 20 mph zones have changed behaviour in differential ways across ethnic groups. Further research is needed to explore these potential factors.

It appears that 20 mph zones are an effective measure for reducing road traffic casualties. Results suggest that historically 20 mph zones have had a role in ameliorating what has been a differential background decline favouring the least deprived areas. However, given that London's boroughs have now targeted 20 mph zones at high collision areas, only a minority of areas eligible for new zone implementation are now in deprived areas. For future 20 mph zones to contribute to narrowing socio-economic inequalities, they would have to be targeted at those high collision zones that are in deprived areas. However, this policy would be less efficient in terms of reducing overall

numbers of casualties. In terms of prioritising future implementation, it would then, be a political decision whether to prioritise overall reductions or reductions in inequality.

Although 20 mph zones have contributed to casualty reduction in all ethnic groups, they appear to have contributed less to reductions in pedestrian casualties and those KSI in 'Black' ethnic groups, compared with 'Asian' and 'White' groups. Although reducing traffic speed and volume is, then, an important strategy for reducing casualties to all London's population, other strategies will also be needed to reduce the higher observed rates in 'Black' ethnic groups. Further research is needed to identify modifiable factors that may mean 20 mph zones are less effective in reducing pedestrian casualties and KSI for some groups.

It is important to note that the majority of collisions occur on roads not suitable for 20 mph zones, and that these collisions may involve more serious injuries. Future efforts to reduce inequalities in casualties will have to address differentials in road casualties on major roads. This study could not compare 20 mph zones with other methods for reducing traffic speed and volume, which could potentially have different effects on inequalities in casualties.

6. Conclusions

At present 20 mph zones are predominantly sited in more deprived areas. This has been the result of, in part, of deliberate targeting by collision history, as historically high collision areas have been in more deprived areas. However, with larger areas of London's residential streets now covered, future implementation in areas which are both high collision and high deprivation is more difficult, and policy makers may face a choice in prioritising in terms of whether to make the largest gains in overall casualty reductions, or in addressing deprivation. The results of this study suggest that 20 mph zones may have mitigated trends in socio-economic area inequalities in road traffic casualties. They do not appear to have played a role in reducing the relatively high rate of casualties in 'Black' minority ethnic groups. In the future, 20 mph zones may continue to have a role in reducing road traffic casualties, but other strategies will be needed to address socio-economic and ethnic inequalities because the majority of collisions occur in areas not suitable for 20 mph zones.

7. Policy implications

This project has only evaluated the effect of 20 mph zones on inequalities for one outcome, that of casualty reduction. The implementation of 20 mph zones in most London boroughs generally aims to meet broader policy goals in addition to overall casualty reduction, including improving local neighbourhoods and reducing road danger. These aims may have gains for equity that are not captured by measures of casualty reduction. Our recommendations therefore take into account both broader road safety policy and broader equity goals.

1) Implications for monitoring

Although a before and after analysis provides a broad indication of the effect of 20 mph zones, evidence from these methods should be used cautiously, especially for assessing *differentials* of effect across deprivation strata.

2) 20 mph zones are an effective way of reducing casualties and worthwhile gains can be made by implementing further 20 mph zones.

The main report, *20 mph Zones and Road Safety in London* estimated that 20 mph zones had reduced casualties by around 42% above background changes, and that further reductions are possible by implementing 20 mph zones in remaining suitable residential areas. We have not examined other potential safety gains from the implementation of 20 mph zones which may have had either mitigating or exacerbating effects on inequalities. These might include changes in the use of the road environment after zone implementation (e.g. more cycling or walking), or changes in the perceived safety of neighbourhoods.

3) If future implementation of 20 mph zones is targeted at areas where there is greatest chance of reducing casualties, this may exacerbate inequalities.

Given the concentration of 20 mph zones in deprived areas over recent years, remaining suitable candidate areas (i.e. residential areas with 'high collision histories') are more likely to be in less deprived areas. Further implementation in these areas is therefore likely to disproportionately benefit those living in the least deprived quintiles, and thus may do little to reduce inequalities. In terms of prioritisation there may therefore be 'trade-offs' between casualty reduction and equity goals.

4) To address inequalities in road safety, broader strategies will be needed.

The implementation of 20 mph zones will inevitably be a minor contribution to mitigating inequalities, because the majority of casualties occur on roads that are unsuitable for traffic calming schemes. To make progress on reducing socio-economic inequalities and the relatively high rate of injury in 'Black' ethnic groups, strategies will need to address these major roads, as well as residential areas.

Further, reducing the speed and volume of traffic will not affect the exposure differentials that are likely to be a major cause of inequalities in the short term. However, over time, there may be an effect whereby more traffic calming leads to greater numbers walking and cycling. This may eventually make these modes relatively safer, thus reducing the relatively higher risk of walking and cycling.

5) Further research is needed in three main areas:

- **Understanding the role of exposure to road traffic in variations in casualty rates**
- **Developing methodologies to evaluate complex road safety interventions**
- **Understanding the broader effects of 20 mph zones on road safety**

The role of exposure (how far different population groups are 'exposed' to the risk of injury) has remained relatively under-researched. Improved understanding of how varying patterns of travel mode and time differ between ethnic groups and socio-economic groups is essential for understanding the observed inequalities in casualties. Further research in this area should focus on both the analysis existing sources of data (e.g. London Travel Diary Survey data), and on the development and validation of better measures of exposure, including instruments to research young people's leisure and travel exposure.

One challenge in investigating the role of single interventions (such as 20 mph zones) is that of accounting for potential confounders, including contemporaneous interventions (safety/speed cameras; other road engineering measures), and the interactions between interventions and road safety behaviour (such as the potential for increased exposure following traffic calming schemes as residents feel safer). An example is the apparent effect of 20 mph zone implementation on casualties in adjacent areas, where there are

likely to have been additional road safety measures not taken into account in this analysis. There is a need to develop robust methodologies for evaluating the implementation of road safety initiatives in ways which account for this complexity. As this is a longer term research aim, likely to be of benefit to road safety planners nationally as well as researchers studying other complex policy interventions, funding could be sought by TfL and partner academic institutions from sources such as NIHR's Public Health Research Programme.

To understand the broader effects of traffic calming schemes in general, there is a need for qualitative research to explore how residents perceive the need for slower traffic, and what effect traffic calming has on their perceptions of their neighbourhood and its safety. There is also a need for quantitative research to evaluate the impact of implementation of 20 mph zones on outcomes such as pedestrian and cycling activity, and confidence in road safety locally. Exploring these factors will aid our understanding of how interventions may have differential effects on different population groups.

References

Bunn F, Collier T, Frost C, Ker K, Roberts I, Wentz R. 2003. Area-wide traffic calming for preventing traffic related injuries (Review). *Cochrane Database of Systematic Reviews.*

Christie N. 1995. *The high risk pedestrian: Socio-economic and environmental factors in their accidents*. Project report 117, Transport Research Laboratory. Crowthorne: TRL.

Edwards P, Roberts I, Green J, Lutchman S. 2006. Deaths from injury in children and employment status in family: analysis of trends in class specific death rates. *BMJ*, 333; 119-122.

Edwards P, Green J, Roberts I, Grundy C, Lachowycz K. 2007. Deprivation and road safety in London: a report to the London Road Safety Unit, London: LSHTM.

Elvik R. 2001. Area-wide urban traffic calming schemes: a meta-analysis of safety effects. *Accident Analysis and Prevention* 33:327-36.

Graham D, Glaister S, Anderson R. 2002. Child pedestrian casualties in England: the effect of area deprivation, Report to IPPR.

Green J, Edwards P. 2008. The limitations of targeting to address inequalities in health: a case study of road traffic injury prevention from the UK. *Critical Public Health* 18:2;175-187.

Jacobsen PL. 2003. Safety in numbers: more walkers and cyclists, safer walking and bicycling. *Injury Prevention* **9**: 205-209

Jones S, Lyons R, John A, Palmer S. 2005. Traffic calming policy can reduce inequalities in child pedestrian injuries: database study. *Injury Prevention* 11:152-156.

Lawson S, Edwards P. 1991. The involvement of ethnic minorities in road accidents: Data from three studies of young pedestrian casualties *Traffic Engineering and Control*, 32; 12-19.

Liabo K, Lucas P, Roberts H. 2003. Can traffic calming measure achieve the Children's Fund objective of reducing inequalities in child health? *Arch. Dis. Child.* 88; 235-236.

Malhotra N, Hutchings A, Edwards P. 2008. Does the decline in road traffic injury in London vary by ethnicity? *Injury Prevention* 14; 333-337.

Noble M, Wright G, Dibben C, Smith GAN, McLennan D, Anttila C, Barnes H,Mokhtar C, Noble S, Avenell D, Gardner J, Covizzi I, Lloyd M. 2004. *The English indices of deprivation 2004*. Office of the Deputy Prime Minister

Steinbach R, Edwards P, Green J, Grundy C. 2007. Road Safety of London's Black and Asian Minority Ethnic Groups: A report to the London Road Safety Unit. London: LSHTM.

Towner E, Dowswell T, Errington G, Burkes M, Towner J. 2005. Injuries in children aged 0-14 years and inequalities: a report prepared for the Health Development Agency. University of Newcastle upon Tyne.

Appendix A

Table A1: Deprivation Model results: Reduction in casualties (1987-2006)

		20 mph zone % (95% CI)	Adjacent roads % (95% CI)	Annual trend % (95% CI)
All casualties				
	1	41.8 (21.0 to 62.6)	7.6 (-4.6 to 19.7)	2.5 (2.1 to 2.8)
	2	42.9 (31.2 to 54.7)	3.1 (-5.9 to 12.1)	1.9 (1.6 to 2.3)
	3	44.7 (27.5 to 61.8)	8.0 (1.8 to 14.3)	1.6 (1.3 to 2.0)
	4	48.7 (41.0 to 56.4)	10.6 (5.6 to 15.5)	1.5 (1.2 to 1.8)
	5	38.3 (31.5 to 45.0)	12.1 (6.7 to 17.5)	1.2 (0.9 to 1.5)
Child casualties (0-15)				
	1	46.6 (29.0 to 64.1)	13.9 (-6.1 to 33.8)	4.1 (3.5 to 4.7)
	2	41.7 (23.8 to 59.6)	-1.0 (-19.2 to 17.2)	3.4 (3.1 to 3.8)
	3	46.1 (26.9 to 65.3)	19.1 (7.2 to 31.0)	3.1 (2.5 to 3.6)
	4	59.6 (50.3 to 68.9)	8.2 (-3.5 to 19.8)	3.4 (2.9 to 3.9)
	5	45.1 (37.7 to 52.5)	11.0 (2.5 to 19.4)	3.0 (2.6 to 3.5)
KSI casualties				
	1	52.1 (30.7 to 73.6)	15.6 (5.7 to 25.5)	4.2 (3.7 to 4.8)
	2	55.9 (37.4 to 74.5)	-0.5 (-18.3 to 17.3)	3.8 (3.2 to 4.3)
	3	43.0 (24.2 to 61.8)	18.2 (7.3 to 29.1)	3.6 (3.1 to 4.1)
	4	57.2 (44.5 to 69.9)	13.5 (4.0 to 23)	3.7 (3.2 to 4.2)
	5	35.8 (28.0 to 43.6)	1.7 (-8.9 to 12.3)	3.6 (2.9 to 4.4)
Pedestrian casualties				
	1	35.1 (5.8 to 64.5)	24.1 (18.5 to 29.7)	4.0 (3.6 to 4.4)
	2	38.0 (7.4 to 68.5)	-2.3 (-10.2 to 5.5)	3.6 (3.3 to 3.9)
	3	30.9 (9.3 to 52.4)	7.1 (-2.7 to 16.9)	3.2 (2.9 to 3.6)
	4	34.9 (23.6 to 46.3)	3.0 (-3.7 to 9.7)	3.3 (2.9 to 3.8)
	5	30.9 (22.8 to 39.0)	4.4 (-4.8 to 13.6)	3.2 (2.9 to 3.5)
Child pedestrian casualties (0-15)				
	1	32.3 (14.2 to 50.4)	11.5 (-10.9 to 33.9)	4.1 (3.4 to 4.9)
	2	41.2 (11.8 to 70.7)	-6.2 (-29.2 to 16.8)	3.9 (3.3 to 4.4)
	3	44.9 (19.4 to 70.4)	11.8 (-6.1 to 29.8)	3.4 (2.8 to 4.0)
	4	61.8 (52.2 to 71.4)	4.4 (-11.0 to 19.9)	4.2 (3.7 to 4.7)
	5	38.2 (24.1 to 52.4)	4.3 (-8.1 to 16.6)	4.0 (3.4 to 4.5)
Cyclist casualties				
	1	21.4 (-18.1 to 60.8)	13.4 (-4.3 to 31.2)	4.1 (3.4 to 4.8)
	2	33.3 (3.9 to 62.6)	1.7 (-33.7 to 37.1)	2.5 (1.3 to 3.7)
	3	30.5 (2.5 to 58.5)	5.5 (-7.2 to 18.2)	2.0 (1.2 to 2.8)
	4	20.7 (-1.3 to 42.7)	10.2 (2.8 to 17.6)	1.4 (0.8 to 1.9)
	5	8.7 (-12.2 to 29.6)	9.3 (-1.8 to 20.4)	0.8 (0.2 to 1.3)

		20 mph zone	Adjacent roads	Annual trend
		% (95% CI)	% (95% CI)	% (95% CI)
Powered 2-wheeler casualties				
	1	48.7 (14.4 to 83.0)	4.4 (-16.0 to 24.7)	1.5 (0.7 to 2.2)
	2	35.3 (9.1 to 61.6)	-5.7 (-20.1 to 8.7)	0.9 (0.3 to 1.5)
	3	34.4 (0.1 to 68.8)	5.1 (-6.2 to 16.3)	0.7 (0.2 to 1.3)
	4	37.4 (19.8 to 54.9)	10.1 (1.4 to 18.8)	0.5 (-0.2 to 1.2)
	5	27.8 (11.4 to 44.2)	21.1 (12.4 to 29.9)	-0.2 (-0.6 to 0.1)
Car occupant casualties				
	1	43.5 (7.8 to 79.2)	-0.1 (-14.2 to 14.0)	2 (1.4 to 2.6)
	2	53.2 (38.5 to 67.9)	9.6 (-2.5 to 21.6)	1.4 (0.9 to 2.0)
	3	53.7 (30.7 to 76.6)	10.8 (2.0 to 19.7)	1.1 (0.7 to 1.6)
	4	60.6 (46.7 to 74.4)	19.2 (12.0 to 26.4)	0.7 (0.1 to 1.3)
	5	50.6 (35.1 to 66.1)	16.8 (8.8 to 24.7)	0.3 (-0.3 to 0.9)

Table A2: Casualty counts by deprivation quintile (1987-2006)

		Number of casualties inside 20 mph zones	Number of casualties on adjacent roads	Number of casualties on outside roads	Total
All casualties					
	1	201	1,924	119,680	121,805
	2	287	2,995	181,349	184,631
	3	355	4,515	185,784	190,654
	4	641	6,490	191,395	198,526
	5	955	8,964	195,269	205,188
Child casualties					
	1	22	181	12,579	12,782
	2	49	255	16,657	16,961
	3	69	369	19,461	19,899
	4	107	629	22,696	23,432
	5	204	833	24,595	25,632
KSI casualties					
	1	25	244	18,893	19,162
	2	31	420	27,373	27,824
	3	42	544	28,115	28,701
	4	62	782	29,048	29,892
	5	121	1,144	29,765	31,030
Pedestrian casualties					
	1	51	288	17,741	18,080
	2	54	545	33,832	34,431
	3	93	854	35,761	36,708
	4	188	1,464	45,756	47,408
	5	305	2,033	50,364	52,702
Child pedestrian casualties (0-15)					
	1	16	76	5,075	5,167
	2	22	123	7,583	7,728
	3	40	213	9,598	9,851
	4	61	332	12,760	13,153
	5	148	491	15,011	15,650

	Number of casualties inside 20 mph zones	Number of casualties on adjacent roads	Number of casualties on outside roads	Total
Cyclist casualties				
1	25	190	9,868	10,083
2	42	321	15,640	16,003
3	54	431	15,460	15,945
4	83	645	17,471	18,199
5	132	886	18,210	19,228
Powered 2-wheeler casualties				
1	28	330	15,172	15,530
2	42	560	27,066	27,668
3	50	840	26,737	27,627
4	79	1,144	28,249	29,472
5	140	1,459	29,496	31,095
Car occupant casualties				
1	84	990	68,149	69,223
2	123	1,308	87,671	89,102
3	141	1,978	90,272	92,391
4	268	2,504	81,144	83,916
5	329	3,523	76,544	80,396

Table A3: Ethnicity model results: Reduction in casualties (1996-2006)

	20 mph zone % (95% CI)	Adjacent roads % (95% CI)	Annual trend % (95% CI)
All casualties			
'White'	33.9 (26.4 to 41.3)	8.5 (5.4 to 11.6)	6.7 (6.4 to 7.1)
'Black'	25.2 (16.0 to 34.4)	9.9 (1.4 to 18.3)	1.1 (-0.1 to 2.3)
'Asian'	40.8 (24.5 to 57.1)	7.4 (-1.2 to 16)	0.3 (-0.6 to 1.1)
Child casualties (0-15)			
'White'	40.1 (29.1 to 51.1)	8.9 (2.0 to 15.7)	8.9 (8.4 to 9.3)
'Black'	23.3 (5.9 to 40.8)	6.6 (-6.2 to 19.3)	2.7 (1.1 to 4.3)
'Asian'	41.3 (17.1 to 65.6)	-2.6 (-24.4 to 19.2)	5.4 (4.3 to 6.5)
KSI casualties			
'White'	50.0 (37.8 to 62.1)	8.2 (0.3 to 16.0)	7.4 (6.8 to 8.1)
'Black'	11.1 (-12.2 to 34.3)	9.6 (-4.1 to 23.3)	2.5 (1.1 to 3.9)
'Asian'	50.0 (20.9 to 79.0)	7.2 (-12.6 to 27)	2.8 (1.4 to 4.1)
Pedestrian casualties			
'White'	32.6 (22.3 to 42.9)	5.2 (-0.7 to 11.1)	7.2 (6.8 to 7.6)
'Black'	-0.5 (-23.2 to 22.2)	2.0 (-11.1 to 15.2)	2.0 (0.8 to 3.3)
'Asian'	27.9 (6.2 to 49.6)	1.4 (-15.8 to 18.6)	3.0 (1.9 to 4.1)
Child pedestrian casualties (0-15)			
'White'	46.5 (33.0 to 60.1)	13.0 (1.9 to 24.1)	8.7 (8.1 to 9.3)
'Black'	12.6 (-16.5 to 41.7)	4.4 (-10.2 to 19)	2.8 (1.1 to 4.5)
'Asian'	28.3 (-6.2 to 62.8)	-12.0 (-39.8 to 15.7)	6.8 (5.2 to 8.3)
Cyclist casualties			
'White'	4.4 (-18.5 to 27.3)	-7.5 (-19.5 to 4.6)	8.9 (7.8 to 9.9)
'Black'	20.2 (-18.9 to 59.2)	4.0 (-20.1 to 28.1)	6.2 (5.4 to 7.0)
'Asian'	21.4 (-34.1 to 76.9)	22.7 (-18.5 to 64)	6.4 (4.5 to 8.2)
Powered 2-wheeler casualties			
'White'	29.5 (13.3 to 45.6)	18.3 (13.2 to 23.5)	2.9 (2.3 to 3.5)
'Black'	8.3 (-21.4 to 37.9)	18.0 (3.1 to 33)	-4.7 (-6.4 to -2.9)
'Asian'	47.0 (8.4 to 85.7)	-5.7 (-40.3 to 28.9)	-6.3 (-7.9 to -4.7)
Car occupant casualties			
'White'	42.1 (29.6 to 54.7)	10.7 (5.5 to 15.9)	8.0 (7.3 to 8.7)
'Black'	38.4 (27.1 to 49.7)	14.9 (5.1 to 24.8)	1.7 (0.1 to 3.2)
'Asian'	44.6 (24.5 to 64.8)	12.2 (3.1 to 21.3)	0.0 (-1.1 to 1.1)

Table A4: Casualty counts by ethnic group (1996-2006)

	Number of casualties inside 20 mph zones	Number of casualties on adjacent roads	Number of casualties on outside roads	Total
All casualties				
'White'	1,199	13,197	278,454	292,850
'Black'	2,250	3,766	51,935	57,951
'Asian'	229	422	37,871	38,522
Child casualties				
'White'	206	981	24,297	25,484
'Black'	121	642	9,117	9,880
'Asian'	58	302	4,742	5,102
KSI casualties				
'White'	136	1,891	42,159	44,186
'Black'	69	488	7,003	7,560
'Asian'	25	270	4,707	5,002
Pedestrian casualties				
'White'	318	2,649	49,656	52,623
'Black'	154	971	12,089	13,214
'Asian'	85	510	7,026	7,621
Child pedestrian casualties (0-15)				
'White'	116	492	11,458	12,066
'Black'	88	372	5,071	5,531
'Asian'	45	172	2,433	2,650
Cyclist casualties				
'White'	186	1,469	25,830	27,485
'Black'	29	209	3,268	3,506
'Asian'	13	57	1,133	1,203
Powered 2-wheeler casualties				
'White'	217	3,037	53,119	56,373
'Black'	56	399	4,824	5,279
'Asian'	13	221	2,186	2,420
Car occupant casualties				
'White'	406	4,727	124,507	129,640
'Black'	170	1,687	26,333	28,190
'Asian'	113	1,297	25,448	26,858